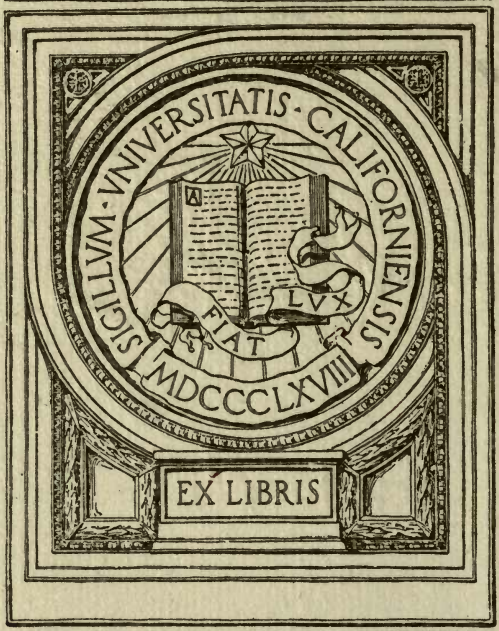

GUIDE

TO THE

AQUARIUM

OF THE

ZOOLOGICAL STATION

AT

NAPLES

NAPLES
PUBLISHED BY H. DETKEN
Piazza Plebiscito and Via Roma 288

STAB. TIP. DELL' UNIONE.

The little book which we here offer to our visitors, is intended to answer, in an easily comprehensible manner, the questions which experience has proved are the first to be put.

These questions partly relate to the novelty of the animal-world exhibited, which is not to be found in other Aquariums, especially those in the north ; and partly originate in the traditions which an earlier stage of science has left lingering in the minds of the uninitiated, without reconciling them with the new, and not therefore always lucid, conceptions of those problems and theories which, the substance and result of a scientific revolution of extrordinary extent, are being ever more spread abroad by popular literature. We have done our best to avoid wearying the reader with the elementary explanations that too often increase the bulk of such guides as this.

The Aquarium of the Zool. Station has for years enjoyed a good name, owing, chiefly, to the circumstance that it is situated in the shores of the richest in animal life of all European seas. This wealth of marine Fauna is reflected in the tanks of the Aquarium, the contents of which often vary, according to the season and the influence of the weather in the fishing. No doubt there exist many much more luxuriously appointed Aquariums in the north, which surprise the visitor by their decorative architecture or beautiful grottoes, but they are like portraits the want of interest in which is compensated for by magnificent accessories, such as velvet dresses, costly furs, and gorgeous frames.

Our Zool. Station is able to dispense with all such pomp, and this is done gladly, in order to use all its available means for the purely scientific aims in aid of which alone it was called into existence.

In conclusion, I beg the reader to note the following preliminary remarks by R. Schmidtlein, the special director of the Aquarium, and author of the guide, for they will facilitate the understanding of the subsequent descriptions.

Anton Dohrn

PRELIMINARY REMARKS.

Not being able, because of the free combinations and constant changes among the animals in the Aquarium, to describe tank by tank in the order in which they stand, we have rather chosen to follow, in a general way, the arrangement of the zoological system, and beg the reader to guide himself with the help of the drawings affixed to the walls of the tanks.

These drawings are provided not only with the scientific Latin name of the animals represented, but also with the common names in the modern languages, and each is marked with the number of the page of this guide in which the description of the animal in question is to be found.

RICHARD SCHMIDTLEIN.

Sponges (*Spongiae*).

For a long time it was doubtful whether these creatures, which, in their fully developed state, are firmly fixed and seemingly immoveable, were plants or animals. Late research has finally shown that sponges are animals, and that their resemblance to plants depends upon a few entirely superficial characteristics.

Sponges consist of an inner fibrous skeleton, surrounded and hidden by a living body of a gelatinous substance. The skeleton is secreted from the gelatinous mass, and consists either of a web of elastic horny fibres (the Bath-sponge and correlatives), or of innumerable microscopic formations of a determined shape (calcareous sponges) which compose the skeleton; these shapes vary in a wonderful manner, and are very ornamental, resembling anchors, stars, balls, hooks, cylinders, and so on.

Each species of sponge is distinguished by the shapes of the particles that form the skeleton, and therefore the special study of these shapes is of great importance in the systematication of sponges.

The sponge best known to the unscientific, the *common bath-sponge* **Euspongia**, has, when the animal is alive, a very different appearance to that which it bears when brought to market. The mass of elastic horny fibre with which we wash ourselves is really only the skeleton of the sponge, and is, in the living animal, covered by a soft jelly-like substance. This substance contains a large quantity of pores which can open and shut, allowing the sea-water to flow into the body of the sponge in all directions. The water is kept flowing through these channels by the action of ciliated hairs, and leaves them by fewer but larger openings. The infusoria and other small organisms contained in the water are retained and absorbed as nourishment by the inner cells of the animal.

Rocky coasts and coral reefs are the chief *habitat* of the sponges ; a few kinds prefer to settle on some other animal. If a sponge be cut into pieces, each piece is still capable of living, and developing into a perfect individual; a capacity of which a very practical use is made by cultivators of the bath-sponge. These sponges are found in all parts of the Mediterranean, and also in the Gulf of Naples. To prepare them for the market it is only necessary to wash and squeeze them, by which process the sponge-cells , that is the really vital part, are destroyed. The finest and most costly bath-sponges are those from the Levant, and are met with chiefly on the coasts of Asia Minor. In 1862, the best were sold wholesale by weight at prices varying from 100 to 150 francs per pound upwards; other kinds, like the so called Zimocca sponge, are worth only the tenth part of that sum; these are generally found on the coast of Greece. The third kind, the horse-sponge, is seen in the market in very large pieces, often measuring a foot and a half. They are chiefly found on the African coast. Sponges from Italy and Dalmatia are also brought to market. Professor Oscar Schmidt says : " These sponges are found from the Quarnero to the Ionian Islands, at a depth of about 20 to 120 feet. The bath-sponge seems particularly to favour the coasts and cliffs, but not the enclosed harbours. Its favorite spot is a steep and rocky coast, and it is seldom met with at a distance from the shore. Sponge-fishing is the exclusive occupation of the male inhabitants of the small island of Crapano. In spring the fishermen go out in pairs in strong open boats to fish, which is a very troublesome business. One man propels the boat slowly forward, while the other stretches his whole body over the bows looking for sponges at the bottom of the sea. If a light breeze ruffles the surface, oil is poured upon it to smooth it. The fisher is armed with a long elastic spear , and with this, when he has got as nearly above it as possible, he loosens the sponge. The sponges are kneaded and squeezed out while quite fresh, and after two or three days the operation is repeated , the cells having then begun to decay. But instead of bringing these clean sponges to market, the Crapanese and other fishermen fill them with fine sand to increase the weight about 90 per cent. Buyers are naturally up to this trick, and it is of no avail, but the beating out of the sand wastes much time in the warehouses, and we all know that the first thing to do with a newly bought sponge is to continue the operation commenced in the maritime towns ".

Besides the bath-sponge, the Aquarium contains many specimens of sponges, which attract attention by their vivid colours and various shapes. We will specially mention the splendid orange-red bunches of the **Axinella** and **Myxilla**, the cups of the **Reniera calyx**, the sulphur-yellow balls of the **Tethya**, and the branching coral-like colonies of the **Clathria**.

The calcareous sponges are usually small and unsightly; the largest species found in the gulf is the **Leucandra aspera**, with white pipe-shaped individuals united on one stock.

One of the many advantages of the Aquarium of the Zoological Station is that of being able to introduce to its visitors *living* sponges. Their surroundings in the Aquarium so nearly resemble natural conditions, that not only is it possible to transport the living sponges thither from the sea, but, during the course of years, various species have settled on the rocky sides of the tanks and flourish there to perfection, thus facilitating their study to zoologists.

Polypes (*Anthozoa*).

If it is strange to the uninitiated to hear animals called *sponges*, which, when seen alive, have nothing of a spongy appearance, he will be no less astonished, when he learns that the word « coral » means something else besides the beautiful red or white branches which are often seen adorning a chimney-piece or a writing-desk. And yet such branches are not the real animals, but only the framework which they construct for themselves, and in which they live side by side, or one over the other, by hundreds and thousands. Of the real coral *animal*, scientifically called *polype* — those polypes give the best idea which are always the chief ornament of northern aquariums, the

Actiniae or Sea-anemones.

In looking at these animals, we see a cylindrical column, the base of which is fixed to some other object, and the upper end of which is crowned with numerous and extremely mobile tentacles.

In the middle of this crown of tentacles there is an easily recognisable opening, which is both the mouth and the anus of the animal. This opening leads into a sort of wide sack, surrounded by the muscular walls of the body, in which the food is digested. At first sight it seems as if the soft naked body of

the polype were sadly in need of protection, but that is not the case; it possesses excellent weapons of defence. In many parts of the body, but chiefly on the tentacles which serve to catch the prey, there are numerous microscopic blisters, the so-called *nettle-cells*, each of which contains an acrid fluid and spirally rolled up filaments. When the animal comes in contact with an enemy or its prey, it darts out some hundreds of such nettle-filaments, and the fluid which issues from them at the same moment has a benumbing and even deadly effect on many of the smaller organisms. The Actiniae, most highly organised of polypes, are uncommonly greedy, and devour not only the bits of meat given it, but catch all the living worms, crabs, snails and fishes that come within their reach. An actinia, a **Sagartia parasitica**, caught and devoured an octopus much larger than itself. A large **Anthea** caught and consumed a shark above a foot long. The extraordinary tenacity of life in the Actiniae very much facilitates their preservation in the tanks; in many cases we have kept the same individual alive for years. One lived, it is said, for more than forty years in a small aquarium at Edinburgh, and during that period brought forth above a thousand young ones.

Among the numerous beautifully coloured kinds we notice the **Anthea cereus**, so often found in the Gulf of Naples, examples of which are seen clustered together on a rock like flowers on a bed.

Still more splendid than this Anemone, which has hitherto been found only in the Gulf of Naples, is the remarkable **Cladactis Costae.** This animal lives at a considerable depth. At first we could not succeed in keeping it alive in the Aquarium, but since the last few years the examples taken live for many months. In its expanded state the *Cladactis* is certainly one of the most beautiful of sea-anemones. The **Sagartia** is interesting from its habits; it lives on the shell of the Hermit-crab, and allows its host to carry it about. The **Actinia Mesembryanthemum** is often eaten in Naples, and the **Anthea** also.

After examining the *Actiniae* it is easier to understand the structure of the true corals. If the Actiniae were capable of secreting an outer or inner calcareous skeleton, that skeleton, after death, would be valued, like « coral », as an ornamental substance. The beautiful orange-coloured **Astroides**, which covers the rocks of the Aquarium, is such an Actinia with a skeleton. Its true form can only be seen when the sky is over-

cast; under such circumstances it erects its body often to the extent of more than a centimetre, its beautiful crown of tentacles unfolds, and when thousands of these animals are close together and all expanded, they look like a precious orange-coloured velvet carpet. But when the sky is bright, they draw in their tentacles, shrink up and look very insignificant. Even when expanded there is nothing to be seen of their skeleton; it is only when they are dead and decayed that it becomes visible, shaped like a honeycomb , the cells of which are filled with radiating partitions. An attentive observer will find these whitish skeletons here and there in the tanks.

Many parts on the coasts of Italy are covered by this coral, and anyone who makes the beautiful trip from Amalfi to Scaricatoio in a boat will see the rocks covered just below the water-line with these yellow creatures. The mighty reefs or *atolls* found in tropical seas are formed of similar corals, and are often many miles in extent and hundreds of fathoms thick. The colour of these reefs is most beautiful.

The branches of the coral are produced by certain peculiar propagating processes, scientifically distinguished as *partition* and *budding*. In the process of partition an organism splits into two or more parts , each of which develops into a perfect animal. The process has been often observed and even artificially induced by cutting a living animal into several pieces. These grow and each gradually becomes an entire polype. A similar thing happens with the coral polypes, but with this important difference, that the partition (natural , not induced) does not extend quite to the base of the animal, but the divided parts remain connected at a certain point. They secrete a calcareous substance which naturally remains connected , and thus , in the course of centuries, are formed those immense coral reefs or islands mentioned above. The second and more rapid process is budding. In this operation the generating organism remains intact, but at one part of it there commences a process of growth by which a second organism is produced , which , however, in the corals, does not separate from the first, but remains connected with the parent organism. Now all these organs are partly supported, partly enveloped, by the varicoloured calcareous skeleton which they themselves have secreted, and which often look like trees or large fungi — such as one sees on the bark of real trees, — or like bushes. But of whatever shape or colour they may be, it must always be remembered that these skeletons are not the animals themselves, but

only their *house*, in the building of which millions of tiny polypes have taken part; while hundreds and thonsands have already died, and their descendents at this day stretch forth their tender prehensile arms, like little brushes or tiny feathery crowns, from the pores of the coral tree.

The precious coral **Corallium rubrum**, the universally known species of this group, owes its great value to its beautiful colour and capability of being highly polished, its stony *axis-skeleton* being hard as marble. The ancients prized it highly, but they had an entirely mistaken idea of its nature — shared even now by very many people, — according to which the precious coral was a plant which was soft and pliable when left in the sea, but became hard as stone when taken out. Careful study has made us fully acquainted with the coarser and finer construction, as well as with the habits and propagation of the precious coral polype, and we know that the stony substance in the form of beautiful branches and twigs, is the product of the coral polypes, which have secreted it as the common support and skeleton of their soft vital parts. If we examine a newly taken and living branch of coral, we find this calcareous substance covered by a softer equally red rind, just as the trunk of a real tree is covered by the bark; and if the coral-branch is carefully hung in a large vessel of sea-water, we shall see, in a short time, the little coral animals, like delicate white flower-cups with eight feathery leaves, unfolding themselves at innumerable points on the surface of the branch. Each of these animals has the before-described structure of a polype, and is vitally connected with all the other individuals by canals of nourishment which intersect the rind in all directions. This rind, like the stem, is also secreted by the animal, and consists of innumerable microscopie calcareous particles like thorns. The intimate blending of these particles, which are deposited in strata, produces the stem. This structure at once distinguishes the true coral from all imitations.

The precious coral propagates by eggs and budding. There are male and female stocks, as well as stocks that carry individuals of each sex; and even hermaphrodites (male and female in one individual) have been observed. In the egg, while yet in the parent-body, is developed a longish pear-shaped larva, which at first swims freely about, but presently attaches itself by one end of its body to some rock, and develops into a coral polype, which in its turn begets other individuals by budding, and thus a new stock is commenced.

The precious coral is found in the Mediterranean Sea. It grows on rocky ground in the neighbourhood of the coasts at a depth of about 240 to 600 feet, seldom beyond that region; and is principally fished on the coasts of Sicily, the Jonian islands, Algiers and Tunis; the last place alone yearly yielding about 60,000 pounds weight of coral, at a value of about two million francs. The apparatus for fishing coral consists of a heavy cross of wood attached to a windlass, and hung with old nets, unravelled ends of rope, and such like. This is dragged along the bottom of the sea, when the jagged branches of coral are caught in the meshes, torn off the rocks, and rise to the surface entangled in the nets. Before working the coral into ornaments, the branches are brushed in order to get rid of the rind with the animals; afterwards the surface of the stem is filed off, and the reddish dust thus produced is sold under the name of *coralline*, and used as tooth-and polishing powder. When the coral has been thus prepared it is polished with emery paper and oil; the beads are turned in a lathe and bored, and figures are worked with the graver.

The value of coral varies greatly, even in the raw material. The larger and thicker branches are often injured by boring animals (worms, sponges) and their value varies from three to ten francs a pound. Commonly good material fetches from twenty to forty francs, the selected rose-coloured coral from two to three hundred francs a pound. Black coral is the precious coral chemically altered by the action of muddy deposits.

A very beautiful coral may often be seen alive in the Aquarium; it is the **Dendrophyllia**, the skeleton of which consists of pure white chalk, and is formed of large branches. The polypes are of a brilliant yellow colour and are crowned when expanded with lovely tentacles. This kind is often met with in the Gulf.

Besides the above-mentioned calcareous corals, there may be seen alive in the tanks some horny corals, fhe **Antipathes** and **Gorgonidae**, which have a flexible horny skeleton. The little trees of the Gorgonidae are vertically branched, which is seen by the direction of the tiny feathers which protrude at regular intervals on both sides of the branch when the polyps expand their tentacles. It is exactly these little feathery brushes that are the living animal. There are white, yellow, and red Gorgonidae, most of the yellow kind are found in the Gulf of Naples. Then there are the remarkable **Alcyoniae**, or cork-polypes, which have no solid skeleton at all, and are therefore

capable of great increase of volume when filled with water. An Alcyonia which, when contracted, looks like a piece of red or yellow sponge, is scarcely to be recognised when fully distended. It is then three or four times its original size, becomes almost transparent and unsubstantial, and is covered with polypes that look like tiny transparent flowers.

Almost still more beautiful are the coral colonies called **Pennatulae** or *Sea-feathers*, which can also expand and contract at will. In the last state they look very ugly, like some shrunken dead creature. But at other times they are distended to transparent beauty, standing erect, with all their wing or leaf-like appendages studded on their upper edges with charming polypes, the tentacles of which may often be observed in motion.

The **Virgularia** or *Sea-rod*, belongs to the same family, but its polypes are not attached to such leaf-like appendages. The *Pennatulae* can move freely about, and bore their fleshy extremities into the sand, an operation which may sometimes be observed in the Aquarium.

Medusae (*Jelly-fish*)

Any one who has visited northern coasts and remembers having often seen ugly jelly-like lumps lying on the strand, looking still more disgusting because of the coloured stripes that cross them, will scarcely believe it, when he sees swimming about in the Aquarium, and is told that they are those very lumps, the large medusae **Rhizostoma** and **Cassiopeia**, or the smaller forms of the **Pelagia**, **Oceania**, **Geryonia**, and **Cunina**. These living medusae make a very different impression to that excited by the ugly dead jelly-fish. Their almost total transparency, beautiful motions, and often splendid colours attract every eye. But on looking at these « animals » the visitor must somewhat limit his idea of what an animal consists of. The Medusae which are nearly related to the polypes have just as little as the latter anything that is like a head, arms or legs. They are merely a sort of shallow reversed cup, not unlike an open umbrella or a mushroom, and move by the rythmic contractions of their gelatinous body. On the edge of the cup are the organs of sight and hearing, and it is generally also surrounded by a nerve-ring. From the centre of the hollow of the cup hangs a long gelatinous transparent stem which is hollow and provided with a mouth orifice. This stem or trunk is sometimes—for example in the **Cassiopeia** and **Rhizostoma**—very broad and consists

of a number of smaller tubes, each of which contains an opening which leads into the common hollow or stomach. From the rim of the cup, which is often zigzagged, there hang long filaments, which the animal can extend or contract at will. They are frequently of great length and when the medusa swims float gracefully behind. They are furnished with numerous nettle-cells such as we saw in the actiniae. They are equally a capital protection for the delicate bodies of the medusae. The disagreable burning sensation we often experience while bathing in the sea, proceeds often from our having come into contact with a medusa, and the effect is sufficient to kill small organisms. Some oceanic medusae, which attain a size of 30 to 60 centimetres, and a weight of 50 to 60 pounds, are even dangerous to man. The rowing of the medusae is a very interesting fact. At certain periods enormous quantities of these creatures collect together and commence their travels; ships are often delayed for hours and even days by meeting these swarms. The animals are so close together that a stick thrust among them remains in an upright position, as if stuck in the mud, and ordinary rowing-boats can scarcely force a passage. Such emigrations are probably the result of over-population by these creatures of a certain ocean-district, and consequent want of food; perhaps also of climatic influences; the small troops that not rarely appear on the coasts and in the bays, are, in all probability, connected with the peculiar process of propagation observed in many medusae and known as alternation-of-generation.

This process, first discovered by the German poet *Adalbert von Chamisso*, while studying salpae during a cruise round the world, has since been enounced as an important scientific theory by the Danish naturalist *Steenstrup*. It consist chiefly in the following changes: an animal which we will call *A* propagates, but the young it produces do not resemble their parent at all, but are quite different animals which we will call *B*; *B* propagates, and again its young are not like itself, but like *A*. In other words: in order that A can propagate A, an intermediate number *B* is necessary.

In the case of many medusae — not in all — this intermediate member appears in the form of a creature scientifically known under the name of a *Hydroid-polype*, which looks exactly like a plant, very similar to a coral stock. The aquarium sometimes contains the **Tubularia, Campanularia**, and **Sertularia**, all representatives of the Hydroid-polypes. They come from the

egg of the medusae, are propagated by partition and budding, and so, like the corals, form larger or smaller colonies. At a certain time they develop buds which fall off the parent stock, and swim about as medusae, in their turn laying eggs from which issue polypes. The Hydroid-polypes are found in immense quantities on rocky coasts amongst the sea-weed. These colonies feed on still smaller animals, such as crabs, worms, infusoria or larvae, which, come within reach of their tentacles and are benumbed by the nettle-cells.

Siphonophores or Siphon jelly fish.

These most wonderful of all sea creatures are equally the delight and despair of the naturalist. Their fragility, for their bodies break at the slighest touch, is as great as the beauty and originality of their structure. They swim, like the medusae, during calm warm weather. close to the surface of the water, and are immediatly seen by the practised eye of the zoologically educated fisherman, who carefully catches them in glasses held for them to swim into. In this glass they are carefully carried to the Aquarium and as carefully emptied into the tank, and so we can often boast of specimens of the **Agalmopsis, Physophora, Forskalia, Praya, Apolemia, Athorybia, Hippopodius, Physalia, Velella**, and others.

The Siphonophores are held by most naturalists to be wandering colonies, that is, creatures that consist of more than one organism and are yet a unity. Individuals of the same species living in one colony or stock in more or less intimate connection is a very common phenomenon in the animal kingdom; coral polypes afford an example on a large scale. But the case is rather different with the Siphonophores; they are no longer uniformly organized individuals, each of which performs the same functions and so is capable, in a certain sense, of independent existence; bus the Siphonophore colonies are composed of very differently formed (polymorphous) individuals, animals that divide amongst them the different offices of the colony and so represent an organically connected whole, or an organism of a higher order. Polype-like eaters provide for nourishment, medusa-like swimming-bells render possible a change of place, and real medusae undertake the business of propagation; in short, there is similar « division of labour » as that found among ants and bees, with this difference, that in the case of these insects the polymorphous individuals lead isolated existences, while, in the Siphonophores, they are inseparably united.

The polypestock of the beautiful **Velella**, or sail-siphonophore, forms a cartilaginous ball, on the underside of which sit the single individuals, while on the upper side is a thing like a sail, which aids the progress of the colony swimming close to the surface of the water.

Ctenophores or Rib-jellyfish.

The Ctenophores are as transparent as the medusae, a quality possessed by many marine animals. There are very many transparent mollusks, and even transparent worms, crabs and fish, as we shall see later. The reason of this property is probably to be sought in the protection it affords to these animals, the ease with which they can both avoid their enemies and catch their prey. For all these delicate creatures are cruel robbers, and devour animals the very contact with which we should think would be sufficient to annihilate them. But their terrible nettle-cells enable polypes and medusae to kill much larger animals than themselves, and one may very often see a small fish in the stomach of the « delicate » medusa, which completely dissolves and digests it.

The shape of the **Beroë** and **Cydippe** (both *Ctenophores*) is like a barrel, the long remarkable *Venus-girdle* (**Cestus Veneris**) is like a ribbon. These three species are often found in the tanks, and attract the attention of the visitor by the rainbow-coloured waves that seem to run along their bodies. These waves of colour are produced by rows of very delicate oar-plates that lie in great numbers close together, and are almost constantly in rapid motion, which breaks the rays of light and causes the appearance of the prismatic colour.

The zoological Station may well be proud of its exhibition of the marine animals now mentioned. The southern position of Naples and the situation of the Aquarium close to the sea, give the latter this valuable monopoly. Succesive days of calm and fine weather during spring and autumn enable the fisherman to catch these rare and beautiful animals. They die, however, very soon, the Sinophophores especially scarcely lasting a day.

The animals hitherto mentioned are scientifically classed under one type, which bears different names, but is oftenest described under that of the *Coelenterata* given by Professor *Leuckart*.

The animals we shall now describe used to be included with them under the common name of *Radiata*, but later research has proved that they are very different. These are the

Echinoderms or Sea-urchins.

To this class belong sea-urchins, starfish, seacucumbers and sea-lilies. It is saying very little when we call them interesting and remarkable, all animals are so, even the sparrow and the common fly, but one must be possessed of various and correct knowledge in order to find it out. The Echinoderms however, are doubly interesting to people who live at a distance from the sea, for nothing like them is to be found either on land or in sweet water; they are entirely novel creatures, true children of the ocean. But this is not the most interesting fact concerning them.

Another peculiarity distinguishes the Echinoderms from all wellknown land and sweet-water animals. It is true that these land creatures are as mysterious and inaccessible to the unlearned, as far as concerns their organisation, as any marine snail, medusa or sea-urchin. But on the whole, the unlearned know that all birds, fish and insects can boast of a head, legs, gills or wings, eyes, mouth and many other visible organs.

But what must we think of a sea-urchin or starfish? These creatures live, therefore they must eat; but where is their mouth? Where are the members with which they seize their food? They live in the sea, but how do they move? Do they swim or creep? Can they see and hear?

The unlearned cannot answer these questions, and will be grateful, if, without superfluous science, this little book tries to explain the essential properties of the Echinoderms.

First of all, we beg our reader to put out of his head all such things as heads and tails, arms and legs, gills and wings; and to be sure that the Echinoderms can do without these members quite as well as the corals or medusae. But the Echinoderms have a much more complicated organisation than any of these last-named creatures.

It is only lately that we have become acquainted with the anatomy of the Echinus and, as usual, the better it is known the more interesting the object becomes.

The outer forms of the Echinoderms vary greatly. Some are as round as a ball, others flat as a leaf; others again are like a star or a sausage, or, to use a more refined comparison, a cylinder; and finally, some have a stem like a flower and seemingly a calyx and leaves. The shell or skin of these animals looks like mosaic. It consists of a great number of differently

sized but regularly disposed calcareous plates. In the *Sea-urchin* (**Echinus**) these plates are joined so that the whole body seems to be in one piece. In the *Starfish* (**Asteridae**), on the contrary, they are more loosely connected and permit motion, and the Starfish can move its arms up and down as well as sideways. This fact is seen best when the animal is on its back and wants to turn over. (The keeper will induce this movement at the visitor's request).

The Brittle-stars (**Ophiuridae**) are so made that their single arm constantly moves like a snake, and the Feather-stars (**Comatulae**) can even swim by lashing their long arms. But the skin or shell of the Sea-cucumbers (**Holothuridae**) has no such calcareous mosaic; it is like a piece of leather dotted at intervals with strangely formed calcareous bits, like anchors, stars and rosettes, so that the skin is very elastic, allowing the animal to stretch and bend its body in all directions. This construction of the skin, however, can scarcely be seen, so covered is it with spines and other appendages. The tiny calcareous plates of the starfish are also not easy to be distinguished, but in dead examples, which the keeper has at hand, we perceive their enormous number, amounting, in some of the large individuals, to a hundred thousand!

You will ask how the Sea-urchins and Starfish move in the water, since they have no legs, and cannot, like worms, and eels, creep or swim by the undulating movements of the whole body? Before we answer this question we beg the reader to examine carefully one of these animals, which he will certainly find either sticking to the glass of the tank, lying on the sand, or climbing on the rocks.

On the side turned to the glass (in the first case) he will see a great number of small transparent tubes, provided at the end with a sucking-disk. These tubes or tentacles are extremely flexible, can stretch and contract like worms, and adhere to any object. They are called sucking-feet, and are connected with a system of water pipes, consisting of a circular channel with branching arms, lying in the central disk of the animal. Each arm has two canals, which are studded with sucking-feet like the leaves on a stalk, and through these canals the sucking-feet are filled with water. The water is received through a sieve-like calcareous plate on the animal's back (madrepore-plate) and is pressed by the contraction of the canals into the sucking-feet. By this alternate expansion, contraction and adhesion the animal pushes itself along on its base.

Such are the general organs of locomotion of the Echinoderms, for the Sea-urchins and most Sea-cucumbers move in the same manner, only, because of their different shape, the sucking-feet of the Sea-urchins are spread over the whole body in five rows, while in the Sea-cucumbers they are otherwise disposed.

The sucking-feet of the Sea-urchin have another very important use, which may often be seen in action in the aquarium. They enable the animal to catch its prey. When an animal which the Sea-urchin can eat comes near, the latter stretches out a few of its tentacles or sucking-feet until they seize the prey. If the victim is not immediatly aware of the attack, it is lost, for other tentacles quickly follow, and the Sea-urchin gradually pushes its whole body close to its prey, which is soon bound fast by hundreds of tiny fetters and brought to the vicinity of its enemy's mouth. All efforts to escape are in vain, for even if some of the sucking-feet are torn, others take their place. So the victim soon resigns itself to its fate, and is slowly dissolved and digested.

The mouth of the Sea-urchin, like that of the Starfish, is on the underside of its body. Many Sea-urchins have very complicated masticatory organs, which are situated in the interior of its body, and enable it to grind even very hard objects. All the Echinoderms in the Aquarium possess these organs. Other kinds live in the sand, which they swallow, digesting the organic matter therein contained and then expelling the useless remainder.

Starfish have no masticatory organs, but the membrane of their intestine secretes such an acrid fluid that it kills the animals they have swallowed, such as shell-fish and snails, frequently also fishes and crabs. The Starfish approaches some animal lying quietly at the bottom of the water, and catches hold of it with its sucking-feet so suddenly that it cannot escape. Starfish are really distructive animals, and ought to be destroyed in the interests of fishing.

Most of the Sea-cucumbers (**Holothuridae**) nourish themselves by taking up sand and mud and assimilating what organic matter they may contain. Others act in a different manner, seldom creeping about, and generally remaining quietly attached to some stone or other object. They then expand their large many-branched tentacles, which are filled with water, and insert them alternately into their mouths.

The Echinodermata are divided into the four classes we have mentioned:

1. The Sea-lilies (**Crinoidea**), 2. the Starfish (**Asteroidea**), 3. the Sea-urchins (**Echinoidea**), 4. the Sea-cucumbers (**Holothuroidea**).

Of the first class the Aquarium possesses the **Comatula mediterranea**, a very beautiful creature, which varies much in colour. Straw-coloured, orange, blood-red and brown-and-white examples may often be seen in great quantities in the tanks. They generally adhere to corals or annelids, so that they look almost like gay flowers springing up in various places.

The Aquarium has a great number of Starfish. There are the **Asteracanthion**, **Astropecten**, **Luidia**, etc. Some of these creatures, for example **the Ophidiaster,** are found on close inspection to be very beautiful, being not only brilliant in colour, but having beautifully marked skins.

The Brittle-starfish or **Ophiuridea** are numerously represented; but they do not so much attract the attention of the unlearned: **Ophioderma longicauda**, etc.

The Sea-urchins, on the contrary, are very striking. Above all the **Echinus melo** is remarkable for its light flesh tint, and size. The **Echinus lividus** and kindred are eaten, that is, the shell is opened and the bright yellow ovaries are taken out and eaten like oysters. The **Toxopneustes brevispinus** is of a very beautiful violet-brown colour, and the **Dorocidaris hystrix** is distinguished by its few but large and strong spines.

Sea-cucumbers are numerous in the gulf of Naples, and the Aquarium can show more than six different species, some in great quantities, especially the large **Holothuria tubulosa**, an immense Sea-cucumber of a brown colour, more than a foot long. Another remarkable Holothuria is the **H. regalis**, the body of which is not round, but square and flat. These Holothuridae are remarkable for a circumstance to which we will now draw your attention. In the body of these creatures is often found alive a beautifull little fish, about 20 centimeters long, the *Fierasfer acus,* which sometimes protrudes its head from the anus of its host. It lives on small crabs, to catch which it must leave its curious quarters.

Certain Holothuridae are eaten, especially by the Chinese; the so-called Trepang is the body of the *Holothuria edulis* emptied of the intestines and dried in the sun or by artificial heat. Thousands of Malays and Chinese are occupied in fishing and drying this food, which European palates find can only be eaten when strongly spiced. Whole fleets of boats sail annually

for the coral-islands between New Holland and New Guinea, in the bays of which the animals are found abundantly.

Worms or Annelids.

Many people dislike the mention of a worm. This is not only owing to the traditional repugnance felt by educated persons for many of the lower animals, but also to the fact that the habits and resort of the few species known to non-scientific people are disagreable. Dusty earth-worms, bloodthirsty leeches, tapeworms, trichines, such are the creatures generally thought of when worms are mentioned, leaving out the serpents, snakes, caterpillars, and other repulsive creatures often included in the list.

But in the sea there live a quantity of worms belonging to the very same genus as the despised earth-worm: namely, the **Annelids**, or *marine worms*, which, in delicacy of form and beauty of colour, are in no way inferior to the anemones or other beautiful inhabitants of the sea. The reader will find this statement confirmed on casting a glance at the annelid-tank in the Aquarium, which rather resembles a garden planted with miniature, beautifully-coloured palmtrees than a collection of « worms. » There, on slender stems, wave feathery spiral crowns belonging to the **Spirographis**; there the **Protula** shoots forth bright-red tassels of a similar form from a white calcareous tube; while in another place a confused mass of such tubes seems set with hundreds of many-coloured little brushes, all as delicate as flowers, reminding one more of the children of the goddess Flora than of animal-forms. And yet all these creatures are real worms, which have built these leathery or calcareous tubes for the protection of their soft bodies, and the above mentioned feathery palm-like crowns springing from their heads are the membranes of their gills. Touch one of these tiny crowns ever so slightly, and it will instantly disappear into the tube; the worm has returned into its shell, with which it is in no place actually connected, and waits a little until the supposed danger has passed. Then, slowly and carefully, the bunch of feathers, looking just like a camels-hair brush, will begin to peep out of the orifice of the tube, and by and bye again spread in full beauty. Even a slight shaking of the water will frighten some of these worms into their shells, and in the smallest kinds this sensitiveness goes so far that they feel even a momentary darkening of the tank caused by the passing of a cloud.

In the sea we may often see such a natural garden, which, looked at through the crystal-clear water of a rocky coast, is really an enchanting sight, and yields to the naturalist a rich booty, not only of such worms, but of many other creatures that there abide.

But not all Annelids secrete such calcareous shells or houses; many kinds roll in the sand, and wet it with their slime, thus forming soft sandy tubes. This is done by the **Terebellae**, whose yellowish-red feelers may often be seen sticking out of the bottom of the tank, where they turn and twist about, seeking food in all directions and looking like a knot of living threads. Other worms cement together little stones, bits of broken shell and such small things; and others again make shells of mud, or dwell in long cartilaginous tubes, open at each end, which look exactly like slender penholders; for example the **Onuphis**. This last kind belongs to those Annelids which creep about with their shells, like the well-known larva of the fresh-water dragon-fly; while the first-mentioned adhere to rocks, pieces of wood and other fixed objects, or stick the bottom of their tubes loosely into the sand. Many kinds are a plague to navigation, for they accumulate in such masses on the keel of a ship that its motion is considerably retarded.

All these animals, when young, have an entirely different form. On issuing from the egg they are larvae of a very peculiar shape, and swim freely about. After a short time they become fixed to some object and then by a complete metamorphosis, change into annelids and begin to secrete or make their tubes.

These tube-inhabiting Annelids, of which a great many beautifully coloured species are to be found in all southern seas, correspond, as a second group, to a not less rich and varied group of free Annelids. The Gulf of Naples has long been celebrated among zoologists as the richest in the latter animals; and already, including the tube-inhabiting worms, more than 300 different species have been discribed. But only a small portion are fit for the Aquarium, most kinds living in the mud, rocky crevices and hollows, and seldom being able to bear the direct influence of the light for any length of time. One of the most beautiful kinds is the *Sea Mouse* (**Aphrodite**), the prickly coat of which has at housand metallic colours. Its nearest relation is **Hermione**, which in spite of its beautiful name, is a very insignificant and disgusting creature, the hooked spines of which easily fall out, stick in the hand

if one touches the animal and cause inflammation. This creature is one of the commonest in the Gulf.

Very imposing are the **Eunice**, which attain a considerable length. The undulating and lively motion of their glittering bodies, which are set with hundreds of fringed gills, has a beautiful effect. But they are very rare, and only to be found in the Aquarium two or three times in a year. The yellow **Halla**, of the same family, is found oftener. Besides the Annelids described, the visitor will find a variety of kindred animals with similar habits; but to mention and describe them all, would unnecessarily exceed the proposed limits of this little book.

Lately the attention of naturalists has been particularly directed to Annelids, because the study of comparative anatomy has discovered points in their organism which seem to support the hypothesis of a connection between these animals and the Vertebrates. At present a lively scientific discussion upon this question is going on, which is a great inducement to pursue zoological inquiry in this direction.

Besides the remaining divisions of worms (not including the innumerable intestinal worms of fishes and other marine animals which, naturally, are not proper objects for exhibition in the aquarium), many other smaller creatures live in the tanks, such as the leaf-shaped, often gaily-coloured **Planariae** or *whirlpool worms*; of the *star worms* (*Gephyrea*) there are the white **Sipunculus**, *Spurt-worm*, which buries itself in the sand, and the green **Bonellia**, which hides its round body in rocky holes, and can extend its thread-like trunk to an enormous length. By a canal in this trunk the animal conducts nourishment to its mouth, which is situated at the root of the trunk. Until now this animal has been a rare guest in the Aquarium, and has seldom shown itself to the visitor for more than a few moments at a time. It is oftener found in the Adriatic than in the Gulf of Naples, but may be collected in any quantity on the coasts of Dalmatia.

We must still notice a very peculiar group of animals, similar to the worms, the **Bryozoa**, or *moss-animals*, so called from the mossy-looking bunches they form. The position of this group in the scientific system has always been very dubious, and even now they are only classed provisionally with the worms. By older naturalists these animals were declared to be related to the polypes, and indeed the spectator might easily mistake the pretty net-like frills of the **Retepora**, or the branching trees of the **Myriozoum** and **Eschara** for corals. But closer examination

has proved that the small animals which form these branches and frills are very differently, and much more highly, organized than the coral polypes. They have a noose-shaped intestine, are provided with a mouth, fringed with ciliated feelers, and have a separate anus; muscles and nerves are also found. All these are things which the polyps do not possess, and their entirely different manner of development also teaches us that these two groups, in spite of their outward resemblance, are not in the least connected. The *Bryozoa* are found in all seas, and reveal an astonishing wealth of forms, the knowledge of which is opened to us by an extensive literature relating to this group. Their division into different kinds according to the delicate microscopic details of their shells is the life's occupation of numbers of zoologists, and lately it has been tried, by the study of their development, to lift the veil that conceals their origin and relation to other animal forms.

Crustacea or Crabs, Lobsters and Shrimps.

These animals form a very peculiar and strictly defined group. Contrasted with the quiet dreamy lives of the zoophytes and annelids, the monotonous motions of the apathetic fishes, or the lazy mollusks and sea-urchins, the active and often comical movements of the different kinds of crabs are very attractive, and we soon discover that the mental qualities of these creatures far exceed those of most other marine animals. We are thinking chiefly of the short tailed crabs and similar animals, which are to be found in one of the smaller tanks; but, as the non-scientific visitor is usually best acquainted with the lobster, we will begin with the latter, and from it try to enable him to understand the remaining forms of Crustacea.

The *Lobster*, (**Homarus marinus**) is, on the whole, an enlarged copy of the fresh-water crayfish, and the visitor will easily learn, from examining the large examples in the Aquarium, what are the principal features of its organisation. The body is divided into a segmented fore-part, covered by a single carapace or upper shell; a head and breast piece and a hinder part composed of jointed rings, forming the "tail" of the lobster, and ending in a fin composed of broad flat plates. In the front part of the head and breast-piece are the eyes, two pair of antennae or feelers, and a little farther behind and below, the mouth, consisting of six pairs of jaws, the three front pairs being distinguished as upper and under jaws, while the hinder ones are called

assistant or auxiliary jaws or jaw-feet. The action of this complicated apparatus may very well be seen, when the lobster or crab is eating. He grasps and turns his prey about with the auxiliary jaws, while the fore-pairs are used for biting and chewing. Behind the auxiliary jaws come five pairs of legs, the first three pairs of which end in claws; the first pair, being of immense size and strength, serves also as a weapon of attack and defence. Even under the tail there are several appendages like legs, which in the female, serve to hold the eggs. If we wish to form a Schema of this physical structure, we first take a series of rings or sections lying one behind the other, of which each section carries a pair of lateral members. These members are differently developed in harmony with the principle of division of labour, and partly serve as jaws and weapons, partly as egg-carriers, according to the segment to which they belong. A similar differentiation is shown by the sections themselves, which are partly welded into one piece, partly connected in a manner allowing of freedom of motion. This differentiation of originally similar parts gives the measure of the animal's degree of organisation, and therefore we consider the crab to be of a higher order than the Annelid, for example, which is also divided into sections, but they are not highly enough developed to serve for different purposes, at least not in such a pronounced manner.

If we examine the lobster more closely, we see that he is almost constantly fanning with his feathery jaws, and frequently moves his legs and tail appendages in a similar manner. This is his way of breathing. Just as lung-breathing land-animals renew the air in their lungs by the rythmic expansion and contraction of the lobes of the latter, so the lobster, by the above-named movements, pumps fresh water in to his gills, which are situated at the base of the legs under the breast-plate.

An important period in the life of crabs and lobsters is when they change their shells, when they may literally be said to creep out of their skins. At such times a crack appears in the hinder edge of the breast-plate, and the lobster slowly pushes its way through this backwards, a troublesome and often dangerous operation, for all the limbs, the thick claws, the eyes, the feelers and mouth-apparatus, must be each drawn out of its narrow case, and even the stomach is skinned! Very often the animal sacrifices one or both of its big claws, and its soft body is in great danger until the new armour has become hardened, and then the animal instinctively tries to hide itself

until this has taken place. Freshly skinned and uninjured individuals look extremely gay in their new bright colours.

Of those habits of the lobster that can be watched in the Aquarium, we specially notice its custom of digging ditches and holes in the sand, partly for hiding-places, partly for burying food, and also its manner towards its companions, with whom it often engages in deadly combat, trying the gigantic strength of its claws with only too much success. The invalids with abbreviated feelers and broken claws sometimes seen in other tanks, are such unhappy creatures wounded in battle or during the moult.

The native place of the lobster is mostly on the shores of North-European seas, where it is largely taken. Lobsters are caught in baskets trimmed with bait; into these they creep at night. Lobsters are rare in the Mediterranean, and they command a higher price in the southern markets.

In the adjoining tank visitors will find a near relation of the lobster: the crawfish (**Palinurus vulgaris**), sometimes called the prickly lobster and often mistaken for the true lobster. But a mere glance shows the difference between them. Its want of claws, its spiny shell, and immense feelers strike even an unpractised eye, and closer comparison reveals numerous other differences, which we leave our reader to find out for himself. The habits of the two animals are, however, very similar, but the crawfish is more companionable, not so warlike and more lively; it likes to climb the rocky sides of the tank, which it does with great agility, and feeds on shell fish, which it cleverly opens with the strong claws of its fore-legs In the Mediterranean it is far more frequent than the lobster, and is found on all the rocky shores of the Gulf of Naples. It endures confinement very well.

One of its relations is the great *Flat-Lobster* (**Scyllarus latus**), a very lazy and clumsy fellow, who passes the greatest part of its life in sitting still in a crevice of the rocks. Its thick body is generally covered with mud and brown Algae (Diatoms) so that it is often mistaken for a stone. It uses its front feelers, which are shaped like two broad shovels, as weapons of defence. The hinder and normally shaped feelers are violet-coloured, and with these the animal constantly feels about. When feeding, it hides its food with its shovels.

There will often be found in the tank containing crabs, the little *Flat-Lobster* (**Scyllarus arctus**), which is of a more lively and decided colour, climbing in troops on the sides of the tank. The *Lioncrabs* **Galatea, Munida** are also near relations.

Of the small long-tailed crustacea that often live in the Aquarium we will mention the delicate, often transparent *prawns* and *shrimps*, such as the **Palaemon**, **Crangon**, **Alpheus**, **Peneus**, **Lysmata**, and others, which are remarkable for their merry way of jumping. The first named inhabits all rocky coasts in troops, and is food for innumerable other creatures, being chiefly used in this way in the Aquarium. The motion of these prawns in walking or swimming is very light and graceful, and their sensitiveness so great, that they feel the slightest shaking of the water, and respond to it by immense leaps. They are also sensitive to sound, as is proved by experiment; their organ of hearing is situated at the base of the hinder feelers, and consists in a little bag lined with fine auditory hairs, and opening outwardly in a slit. The waves of sound cause these fine hairs to vibrate, and the motion is communicated to the auditory nerve. But to strengthen the sound the ear-sack contains so called *auditory stones*, concretions which are often lost, and then the animal replaces them by little grains of sand, which it sticks into its ears!

A rare creature among shrimps is the **Stenopus spinosus**, an extremely delicate and pleasing animal, which may now and then be found in a separate tank in the Aquarium.

We will now turn to a curiously developed crustacean, which may be called an intermediate member between the long-tailed crustacea just described and the **Brachyura** or short-tailed crabs. It is the *Hermit-crab* (**Eupagurus**).

A whelk-shell running on the legs of a crab, and carrying sea-anemones on its back — such is the first impression made on any person looking at a hermit-crab for the first time.

The droll figure, which seems composed of parts of three different animals, at once interests us and excites a wish to learn more about it. The matter is simpler than it seems, and is explained as follows. Hermit-crabs are animals who take up their quarters in the empty shells of Mollusks, gathered at the bottom of the sea, and chosen according to the size, that is, the age, of the crabs which intend to inhabit them. When the crab has chosen his house, he inserts himself into it backwards, and fastens himself firmly by the hind part of his body. This hind part has become, in the course of many thousands of centuries of adaptation to this mode of life, altogether unsymmetrical and soft, and resembles a long bag furnished with a pair of little hooks at the end for sticking fast in the shell, and by this means the animal adheres so firmly to

its dwelling that it is torn if we attempt to drag it out. The shell protects the soft body of the crab, and is generally so big, that the crab can completely conceal itself when in danger. As the animal grows, it must naturally remove to a larger shell, which operation is effected with great skill and caution. Having found a shell to suit him, the crab first carefully examines it all over, poking his claws into it to make sure that there is nothing suspicious at the bottom, and, if all is right, he at last carefully prepares to effect the removal. He gets hold of the shell with his claws, places it upright with the opening turned towards him, and then, with one quick movement, forsakes his old shell and slips into the new one, as if he very well guessed what a tit-bit his soft and juicy body would be for a hungry fish.

Bnt what business have the sea-anemones that are regularly settled upon all the shells occupied by hermit-crabs, often from three to six in number, and yet nowhere in any bodily connection with the crab? The fact is, that the hermit-crab and the sea-anemones have formed an alliance. The latter protects the crab from its enemies by means of the poisonous nettle-cells of its tentacles, while the vagabond habits of the crab give the anemone a greater chance of finding nourishment, for the latter is being constantly brought into contact with all kinds of animal life, or else catches the bits that fall during the crabs own meal. This fact is proved by the beautiful purple-spotted Anemone **Adamsia palliata**, which always fastens on the shells inhabited by the **Eupagurus Prideauxii** and is usually so placed that the orifice of its mouth is turned downwards. But the most wonderful thing is that the crab knows its friends, and not only tries to put anemones on a shell that is without them, but actually, when it changes its abode, takes its companions along with it!

An experiment, in which all the sea anemones were taken away from the shell of a hermit-crab, and replaced before the eyes of the experimenter by the crab pressing them with his claws out the shell until they had again fastened, places the above fact beyond all doubt, and proves the alliance to be one of the most remarkable known among the lower animals.

The life of the hermit-crabs in the Aquarium offers a picture rich in varied and amusing scenes. The droll fights of the little troop, the impudent seizures on the one part and the resolute defence on the other during the common meal, involuntarily excite the laughter of the spectator who is often greatly surprised

by various traits of artful and calculating utilization of the situation on the part of these little creatures. Hermit-crabs come next in rank to the short-tailed crabs, to which we now turn our attention.

In the hermit-crabs we found a retrograde development of the hinder part of the body in consequence of the long continued habit of living in shells. In the short-tailed crabs this retrograde formation has gone much further, but in favour of another principle, that is, of fredom of movement. Here we see the larger portion of the body, which in the lobster we called the tail, reduced to a small round or three-cornered plate, which is doubled under, the edge lying close to where the legs begin. In the female this plate is hollowed like a dish for the reception of the eggs; in the male it is simply a pointed three-cornered plate stuck fast into the niche destined for its reception. But the forepart of the body is developed crosswise and is generally of an oblong or square shape. The wellknown purse-crab may serve as a type of this group ; it is familiar to most people from collections, engravings or personal observations.

We will next draw attention to the crabs with a three-cornered head-and-breast plate, of which the species **Pisa, Lissa, Maja, Inachus**, and **Stenorhynchus** are the most interesting. What will most strike the observer in these animals is their being covered by all kinds of foreign substances. One carries on its back and legs a complete forest of algae and moss-animals; another glories in a strange decoration composed of the stems of Hydroid polyps, which , grouped in a bunch , adorn the spikes of his forehead ; others, for example the **Inachus** drag about, clinging to their long thin legs , plants , sponges and ascidiae ; — in short, the more crabs we examine the greater variety of toilettes shall we see: and their use ? They are the best possible means of concealing the animal from its enemies and from its prey. All these things have not voluntarily fastened themselves to the crab , but have been artistically placed there by itself, with — wehardly dare say — conscious intention, but certainly with an hereditary instinct that impels the animal thus to disguise itself; and the mask, in many cases, is so successful, that it even deceives the knowing eyes of men. All these three-cornered crabs are extremely sedentary, and, as they remain motionless when alarmed, exactly resemble stones overgrown with moss or sea-weed. Their apparatus for fastening these foreign bodies in their backs consists in a number of hooked bristles, arranged according

to a certain law all over the body, and between which the crab with its claws very cleverly hooks fast the algae and other things. The large **Maja Squinado**, *sea-spider*, or more correctly, *spider-crab*, for there are no spiders in the sea, covers its back with little stones and shells, instead of with such a miniature wood. Among the crabs with four-cornered bodies we meet with similar habits. The **Dorippe lanata** gets hold of any living or dead body within its reach, holds above its body with its hinder reversed legs, and thus shielded, stalks proudly about. Whatever it may find, — sea cucumbers, ascidiae, crabs, star-fish, fish heads, bits of glass or wood — in short anything and everything which can serve as a shield, is annexed without further ado, and naturally, in case of the desired shield being a living animal, there ensues a comic conflict between the instict-obeying crab and its reluctant victim. Another animal the **Dromia**, or *wool-crab*, covers its back with a certain kind of sponge — the orange-coloured **Suberites** — so completely. that when looked at from above nothing is to be seen of the crab but its legs. These crabs are also provided with a pair of legs turned backward for this purpose, which hold the sponge fast. The **Homola** and **Ethusa** have similar habits. The simplest mode of escaping danger is by burying in the sand, a habit seen in the **Calappa**, or *bashful crab*. With a few vigorous movements of its large shovel-shaped claws, this animal buries itself up to the eyes and carefully examines the neighbourhood from its retreat.

The same habit is seen in the active shore-crabs, such as the **Carcinus**, **Pachygrapsus**, **Eriphia**, and the **Portunus** and **Lupa**, whose slyness and activity are really astonishing, and, with their ability to move on the land, indicates a higher organisation. Whoever has tried to catch these crabs in their natural haunts will remember the difficulty he had to secure even one, and also the cleverness with which the little fugitive availed itself of every cranny, and the bold manner in which it defended itself when driven into a corner. The strong **Eriphiae** are especially ready to fight and pinch with their powerful claws everything held out to them. In the Aquarium we have seen them break thick glass tubes in this manner. All shore crabs can live for a long time out of water, and move on land with almost the same agility as in the water.

Besides the above described crabs with five pair of legs, we must notice one belonging to a lower order. This is the *grasshopper-crab*, or **Squilla mantis**, a slender, active and pre-

datory animal, which in many respects reminds one of the *Mantis religiosa*, or praying mantis, a land grasshopper. Its legs especially — which are provided with pointed claws that snap like the blades of a penknife, and can be darted at the victim with great velocity and strength — resemble those of the Mantis. The Squilla is a very clean animal, and almost constantly occupied in carefully cleaning all parts of its body. It may be seen making its toilette in all sorts of attitudes. Now the eyes and feelers, now the mouth and its parts, now the legs and segments of the body are brushed and stroked till no foreign particle is left adhering to them. The object of this scrupulous cleanliness noticeable in many crabs and insects (for instance, the common housefly) is scarcely æsthetic, — we rather suppose it to be a very practical one — the preservation of the different delicate sense-organs.

The great army of *crabs of the lower order* — of the variety of whose shapes the naturalist alone has till now the slightest notion — is far less adapted for exhibition in an Aquarium than the higher crustacea. This is partly owing to the small size of most kinds, which is often combined with complete transparency, so that they can only be seen with a glass; and partly to many being parasitic and hidden in the intestines of other animals. We must therefore confine ourselves to mentioning the most striking of those now and then to be found in the Aquarium, aiding our discriptions by explanatory remarks.

The visitor will often find, sticking to some fishes, especially to the wrasse, the parasitical species **Anilocra** and **Cymothoa**, belonging to the sub order of the *Isopoda*, for which the well-known wood-louse — a crab converted to a life on land — may serve as a type. They fasten themselves into the head, the eyes, or the tail-fins of a fish, boring into it with their mouths and the sickle-shaped claws of their seven pairs of legs; or they are found in the gills and throat of their victim. The Anilocra attains a length of about an inch and a half. These animals hook themselves so firmly to their victims that no effort of the tortured animal can shake them off. The female parasite carries her brood in a particular place on her belly until the young are ready to creep out.

Most species of the group *Hay-crabs* or **Amphipoda** — of which the reader is perhaps acquainted with the **Gammarus pulex** or common flea-crab that lives by thousands under the pebbles of running brooks — live in the sea. The north and arctic seas especially are so full of these active little animals

that the carcases of whales or other large sea-creatures are soon reduced to skeletons by their aid. Particularly interesting are the *Hyperine*, to which belongs the **Phronima**, a little pelagic crab of crystal transparency that, strangly enough, lives in and on the bodies of young Pyrosoma which it eats until they are reduced to mere empty little barrels, and then uses them as moveable habitations. The Phronima fastens itself by its forelegs within this empty barrel, sticks out the hinder part of its body, and using its tail-appendages as oars, swims about, carrying its jelly-barrel with it. This small Diogenes also uses its barrel as a nursery; for not only does it fasten its eggs to the inner walls, but the young ones remain in it for a considerable time even after they have crept out of the eggs. This creature is caught in the surface of the sea in surface-nets, together with jelly-fish, Siphonophores, and other representatives of the pelagic jelly animals; especially in winter and spring.

The **Cirripedia** are considered to be the lowest order of the Crustacea, and are so unlike the typical form, that it is only quite lately that naturalists have clearly recognized their nature. Even Cuvier thought the hard-shelled **Balanus** and **Lepas** were mollusks, until subsequent examination — observations on the structure of the young ones and the minute anatomy of the adult — proved them to belong to the Crustaceans. How much more difficult must it be for a non-scientific spectator to accustom himself to the idea that these creatures, so unlike in appearance, are indubitable relations of the well-known crabs. It may be of assistance to know that their mollusk-like form is the result of a very extensive retrograde metamorphosis. When young, all these creatures are very lively, freely jumping about in the water. They have a pear-shaped body and three pairs of feet that serve as oars. This form is zoologically called the *nauplius*-form (just as the common larvae of the larger crabs are called *zoëa*). But after several ecdyses they fix themselves by the heads, the skins secrete a covering composed of calcareous plates, which completely hides the crab and permits the feet only to protrude through a gap. The movement of these segmented feet may be beautifully seen in the *Balanus* as well as in the *Lepas*. For these animals are continually moving them in order to conduct a current of fresh water to their gills and mouths. On the edge of the rocky coasts of all seas the Balani form a characteristic border, and cling so fast to the stones that the heaviest breakers cannot destroy

them. They bear equally well being left dry during ebb-tide, the small quantity of water they retain within their hermetically closed valves enabling them to resist the greatest heat of the sun. Many kinds are found settled on whales in heaps.

The *Lepas* settle by preference on floatings bodies, ships, pieces of wood, and similar things being covered by them. Their name is derived from the fable that out of them is developed the barnacle-goose (1).

The **Scalpellum vulgare** also belongs to the Lepadidae. It is a deep sea animal remarkable for its sexual condition. These animals are hermaphrodite, but as if to secure the preservation of the species, they carry, in a special bag or pocket, several dwarf or complementary males of infinitesimal size!

The most remarkable thing in retrograde metamorphosis is afforded by the parasites known as *root-crabs*, which live on the hind parts of prawns and hermit-crabs. They are nothing but unshapely sacks filled with eggs and connected with the bodies of their victims by a short stem and a bunch of branching sucking tubes, through which the animal juices are drawn. The nature of such forms which parasitism has caused to degenerate until they have lost all resemblance to crabs, could only be determined by naturalists by the study of their development; and indeed the problem was only solved when the nauplius-larvae were discovered.

Mollusca.

The highest developed class of Mollusks is that of the Cephalopods, distinguished by a head separated from the body, and a mouth-orifice surrounded by prehensile arms. The Aquarium contains the following kinds:

The *Eight-armed sea-poulp* or *octopus* (**Octopus vulgaris**), frequently found on the rocky coasts of the Mediterranean. This creature has a body like a bag, which we see breathing with a rythmic motion; this is the body proper of the animal and contains the intestines. The small head at the top contains the two large eyes, and from it proceed eight arms covered on the under-side with sucking-disks. The mouth lies in the cen-

(1) This myth, which can be traced back to the 12th century, probably owed its origin to the monks of that period, who wished to add something to the scanty fare allowed during fast. At least according to credible witnesses, it was affirmed by Irish and French bishops that barnacle-geese were produce of the sea, and therefore no flesh.

tre, hidden by the intermediate skin that connects the arms at their base. This mouth is armed with hard mandibles, something like the bill of a parrot. When the animal breathes, we see at one side of its body a slit or fold in the skin which alternately opens and shuts and from which, when it is open, protrudes a short thick tube or siphon, the movements of which alternate with that of the slit. This latter opens into the cavity that contains the gills, and through it the water enters. The slit is shut during expiration, the exhausted water being expelled through the tube or siphon. This organ also acts as a swimming apparatus, for the impulse of the expiration drives the animal at will backwards through the water, while the arms, rapidly extended or contracted, increase the strength of the stroke. With its arms the octopus can also creep and climb as well as seize and hold its prey. The arms are provided with a double row of sucking-disks, which act as an adhesive apparatus. The food of the octopus consists chiefly in crabs and fishes. The octopus is a powerful robber, lying in ambush for its prey among the rocks. In the Aquarium these creatures drag large stones into a heap and hide behind them, and, in such a case, their power of changing colour and imitating that of their surroundings is of great use. They grow to a considerable size, and gigantic examples observed in the ocean are the historic germ of the legend of the Kraken. Pliny relates a story of an animal of this kind which came at night to the fish-tanks of Carteja, and frightened the dogs away by its snorting and its terrible arms. Its head, which was shown to Lucullus, was as large as a barrel holding fifteen amphorae of wine; its arms were so thick that a man could scarcely clasp them, and thirty feet long; each sucking-disk contained a jar of water. Montford told of an octopus that tore a couple of sailors from the rigging of a ship near St. Helena; the end of one of its arms, which caught among the tackle and was hewn off, measured 25 feet. Later reports of a gigantic octopus have been brought by the French ship Alecto, which met with one on the 30 November 1861 between Teneriffa and Madeira. The animal measured from 15 to 20 feet, not reckoning its immense arms. Its colour was brick-red; its eyes enormous, with a frightful rigid stare. Its weight was reckoned at 2000 kilogrammes. After pursuing it for three hours the crew only succeeded in cutting off part of its body.

The octopus is caught on all Mediterranean coasts; it is enticed by bait, at which it rushes, and is then drawn up by a

string. It is frequently found in the fish-market, for the arms of the younger animals are eaten and highly prized.

A near relation of the Octopus is the **Eledone moschata**, the *musk-eledone*, smaller than the animal just described, and furnished with only one row of sucking-disks in each arm. They are shy creatures, fond of hiding in corners; when taken out of the water a delicate odour of musk is perceived. They are very numerous and common in the market, but generally eaten only by the lower classes.

One of the most interesting and important cephalopods is the *Sepia* (**Sepia officinalis**), or cuttlefish, more correctly, cuttle-snail. Its body is oval and flat, sorrounded with a hem of fin. Beneath the skin of the back is found the bone known as *os sepiae*. Its arms are much shorter than those of the octopus, and are usually folded together in a point. Hidden amongst them is a longer pair of prehensile arms which are darted forward when the animal catches its prey.

What is most interesting in the Sepia are its powers of excreting an inky fluid and changing colour. The former is common to all the species, but the sepia makes a more frequent and abundant use of it. This colouring matter, used by artists, is the product of a gland, the so-called ink-bag, the contents of which can be emptied out of the siphon. A small quantity of this fluid expelled with the water is sufficient to enfold the animal in a black cloud, frightening its pursuers and covering the animals's retreat. This colouring matter is dried and sold in the market, and can even be obtained from fossil animals in a useful state.

The wonderful play of colour in the living animal proceeds from the cells of the skin, which are filled with an extremely thin colouring matter; muscular fibres, that stretch these cells and alter their size and shape, occasion an almost constant change of tint and the appearance and disappearance of stripes, spots and clouds of colour, that are visible or not, according as the animal is excited or at rest. Besides this, we notice a peculiar glittering and iridescence of the skin, occasioned by the breaking of the rays of light through the tiny plates or spangles lyingh thick below the colour-cells. The sepias are perfect masters of this play of colour, as is proved by their adopting the tint of the sand or rocks on which they lie. The sepias are of different sex. When the male courts the female its excitement causes its skin to assume the most brilliant colours. There may then be seen vivid zebra like stripes, while the eyes have

a metallic bluish glitter. After pairing, the female lays its large, black, pear-shaped egg-capsules singly upon the branches of coral or algae, usually close together, the whole looking like a bunch of grapes. When the young leave the eggs, they are exactly like their parents, and at once begin to change colour and spurt ink. The sepia is in great request in the market; the meat is eaten and the bone or shell used for polishing wood and making toothpowder.

Among the inhabitants of the Aquarium may be seen, particularly in winter, the *Calmar* or *Squid* (**Loligo vulgaris**). These semitransparent creatures, shaped like winged arrows, are unfortunately far too sensitive for confinement. Beating their delicate wings like a flock of birds, they continually swim backwards and forwards without turning until they die, which is generally a few days after they are caught. They are never seen at rest, and the slightest disturbance throws them into violent agitation, when they dart about like arrows, and their milk-white bodies seem to blush rosy-red. They are fed with small shrimps, and, when feeding, use their prehensile arms like the sepias. They are greatly liked as food. Their bone or shell is transparent as glass, very flexible, and shaped like a feather. They excrete the inky fluid in great quantities, whence their Italian name of *calamajo* (ink-pot).

The *Snails*, like the cephalopods, have generally a clearly distinct head, and a memberless body provided with a flat base for creeping, the so-called foot. In many species, the greater part of the abdomen is enclosed in a spiral calcareous shell or house, into which the rest of the body also can be withdrawn. This shell is excreted by the so-called mantle, a fold of the skin, and is connected with the animal only by a muscle. Scientific conchological selections bear witness to the beauty of these shells in form and colour. Most kinds belong to marine snails. The chief of those from the Gulf of Naples which are in the Aquarium, are the following:

The *Worm-snail* (**Vermetus**); remarkable for the irregularity of its shell, which is fixed to one place. At first sight it exactly resembles the twisted calcareous tubes of the Serpulae, a group of hairy marine-worms; — but on looking closer, you recognize the stopper-shaped head of the snail, with its short feelers, and see that it is very different from the brightly-coloured feathery head-gills of the Serpulae. These animals feed on the little cray-fish and worms that play near them in the water. When they are disturbed, they at once retreat to the bottom

of their shells. They stick their eggs to the inner sides of their house; when the larvae issue from the eggs, they swim about, until, after a while, they also settle in one place.

The **Murex** or *purple-snails* are represented by many kinds (*M. trunculus*, *brandaris*), which belong to the commonest shells of the Mediterranean, and in ancient times played an important part. For from these mollusks was obtained the real purple used by the ancients to dye their royal garments. This purple substance is excreted from a gland lying in the animal's mantle, and, when freshly taken, is white or slightly yellow. Placed in the sun it changes to lemon-colour and green, and then to a beautiful violet, which becomes darker and darker the longer it is exposed. The shade depends on the quantity of matter used, so that the dyer can obtain any tint he desires. The making of this purple dye was a large branch of industry among the ancients, and factories for the purpose were scattered all over Italy and Greece. Monte Testaccio in Rome is formed of the refuse from the greatest of these factories. Also in Aquileja traces have been found of a purple-dye factory. In our days the industry has entirely vanished, though the colouring matter, so susceptible to light, is very well adapted, as experiments have proved, for photographs on silk and other fine stuff.

The *Tritons-horn* (**Tritonium nodiferum**) is a large plump snail, with protruding head, feelers provided with eyes, and a long elastic proboscis. This snail creeps slowly about at the bottom of rather deep water and lives on animal food. Its heavy, beautifully-twisted shell was used in ancient times as a war-trumpet, and even now is employed as a signal-horn by workmen (for example, the master-masons in Naples use it to call their people together). For this purpose the point is cut off and you blow through the hole. The peculiar rushing sound heard in holding a large shell to one's ear is produced by the resonance of its hollow convoluted interior, which rejects the waves of sound. In an absolutely quiet place the shell would not sound at all.

The *barrel-snail* (**Dolium galea**) is the largest in the Mediterranean, with a thin shell, shaped like a barrel, a white body spotted with dark brown, and a large proboscis. A peculiarity of this animal is the shape of the salivary glands, which attain considerable size (1 ½ inches in diameter), and exude a fluid containing more than 2 ½ per cent of free sulphuric acid and nearly ½ of free muriatic acid. When defending itself, the animal spurts out of its mouth a considerable quantity of

this fluid. Until this day it is a riddle how such corrosive mineral acids can be freely produced and retained in the body of these snails.

Akin to the above animal is the *Helmeted-snail* or **Cassis** of which one kind (*C. sulcosa*) is often found in the Aquarium. In habits and frequency they resemble the Barrel-snails, and are much prized for the beauty and elegance of their shells. It is from the shells of many kinds of this snail that are cut the well-known shell-cameos. For this purpose suitable pieces are sawn out, and the exterior polished, while the interior is left untouched. The relief is then worked out, use being made of the different-coloured layers.

To these shell-carrying snails is related a group of mollusks, distinguished as mollusks with hind gills, because, contrary to those we have just described, their gill lies behind the heart. They either have no shell at all, or it exists in a rudimentary form, hidden in the mantle, similar to that of the naked common snail (*Limax*). To this group belongs

The *Sea-hare* (**Aplysia leporina**), a dark brown , rather large snail , with two pair of feelers, the hinder ones , which stand erect, actually resembling the ears of a hare , whence the name , *sea-hare*. The mantle is extended into two large wing-like flaps, by means of which the animal swims. Usually creeping lazily among the rocks, when it wants to swim it fans the above mentioned flaps until the movement raises it from the ground. Once afloat, it swims well and quickly, but only for a short time. When teazed, it expels not only the water contained in its body, but also a beautiful violet-coloured fluid, which, like the ink of the Sepia, serves as a weapon of defence. Chemical examination proves that this colouring matter has the properties of a concentrated aniline solution, and reacts in the same manner as an artifical aniline dye. The poisonous character of the fluid seems to have been known to the ancients, for Latin authors mention its being used for charms and poisonous draughts, after taking which the victim suffered torture until the sea-hare dies. Large snails yield about two grammes of pure dry colour.

The Aplysiae are vegetable feeders, and graze on the weed at the bottom of the sea in troops. It is a pretty sight when several stones overgrown with algae are brought to these snails in the Aquarium. They come creeping from all sides to feed, and in a few hours the stones are denuded of all the vegetable matter. The Aplysiae endure confinement capitally on this food,

grow and thrive, and often lay their eggs in the form of long, yellow-and-violet twisted strings, which hang from the sides of the tanks.

One of the most beautiful among these hind-gill snails (*Opisthobranchia*) is the large **Tethys leporina**. It has a delicate, white, half-transparent body, a head distinguished by a large umbrella-shaped sail, and its back is adorned with two kinds of appendages in a double row: that is, small bunch-shaped transparent gills, and larger, hollow, pear-shaped fringes crossed by bright red-and-black lines; the function of these fringes is still unknown. They easily fall off, especially shortly before the animal dies.

This snail belongs to the periodic inhabitants of the Aquarium, like the pelagic animals. It is caught by the fishermen in glasses when floating on the surface of the sea, and when fresh and lively, is a beautiful object, so transparently white, with its coloured fringes and graceful motions in swimming. It swims by alternate pulsations of its sail and quick undulations of its body. In confinement it rarely lives more than a few weeks.

Among the larger specimens of the hind-gills, we must mention the **Pleurobranchus**, which has a shield-shaped mantle and lateral protruding gills. Also several species of the **Doris**, with a feather-like tuft of gills on the hinder part of the back. From these snails come the yellow and white tangled jelly-like strings, containing thousands of eggs, that are seen glued to the rocks of the tanks.

The Mollusks also furnish a contingent to the pelagic world of crystalline-animals. Besides the transparent Medusae we find the wonderful *Heteropods* or *Keel-snails*, and the *Fin-snails* (*Pteropods*). Especially in spring and autumn, when the sea is crowded with pelagic animals of all kinds, then these small and lively creatures make their appearance either periodically or at incalculable periods. But they cannot endure confinement long, sometimes living only a few hours, and on this account they are rarely to be found in the tanks. — Among the keel-snails the genus **Pterotrachea** deserves special notice. These animals are long and transparent as crystal, with proboscises bent like a knee, axe-shaped oar-fins (which answer to the foot of a snail), and a knot of intestines glittering like silver. These creatures swim actively by rapid lateral mo-

tions of their flexible bodies, and rapaciously catch with their elastic hooked tongues all the small pelagic animals that surround them.

The *fin-snails* have a curious shape, which differs in almost all respects from that of the typical snail. The head-part is only indicated by a mouth surrounded by rudimentary feelers. The body, which is of various shapes, is frequently hidden by a delicate shell; but the most singular organ is a pair of large wing-like fins, which are situated on the head or neck, and are used by the animal like the wings of a butterfly. The people call this creature *farfalla di mare* (sea-butterfly). The most frequent kind is the **Hyalaea**, with a palebrown horny covering, and large ever-moving fins. It often appears in swarms, but in the Aquarium lives scarcely a day.

The **Cymbulia** and **Tiedemannia** are much rarer.

The *Shellfish* are the lowest group of mollusks. They are externally distinguished from the snails by their shell, which invariably consists of two moveable valves, that close by means of a muscle, and open, when the muscle is relaxed, by means of an elastic band on the so-called *lock*. The want of a head is an important characteristic of these animals. The organ of locomotion is a foot generally shaped like a wedge or tongue, and capable of being pushed forward by swelling. The body is covered by the leafy gills and mantle-plates, which secrete the shell. These mantle-and gill-plates lie under the shell like the leaves of a book. The internal organs are: an intestine, a liver, a heart, kidneys and the organs of generation. The ciliated membranes of the gills and the mantle conduct the water containing air and nourishment. A nervous system and organs of sense (ear-bladders and often eyes) are found in all these animals. — The greatest number of shell-fish belong to the sea, where they either stick immoveably to some object, like oysters, or hide in the mud, and are capable only of extremely slow movements; very few canswim or jump. From the large number of those living in the Mediterranean we will choose the most interesting and important.

The common *mussel* (**Mytilus edulis**) has a blueblack three-cornered shell with a pointed whorl. This animal possesses a so-called byssus-gland, from which it spins horny threads or byssus wherewith it fastens itself so firmly to rocks or piles that the most violent breakers or currents of water are unable to

tear it loose. When it wishes to change its place, it spins new byssus-threads, and tears the old ones. By repeating this operation it slowly moves forward. The mussel thrives best in north European seas. where it is in fact the object of extensive culture. So-called mussel-logs are sunk into the sea for the mussels to settle upon, and are then drawn up from time to time covered thickly with the animals in all stages of development. In the market at Kiel about 800 tons of mussel are sold annually, each ton containing on an average 4200 animals, so that altogether 3,360,000 mussels are taken in one winter.

Very interesting in its habits is the *Stone-mussel* (**Lithodomus lithophagus**). It is always found in holes made by itself in the rocks or in corals. The smooth oval shell is brown and shining, the animal a favourite food, and therefore often in the market. How these creatures bore into the rocks is still undetermined. Their shells being perfectly smooth, they cannot make holes by filing, as is the case with the Pholas or boring-mussel. It is probable that the effect is produced by the dissolving power of some animal secretion. Internally the holes made by the Lithodomus are perfectly smooth and regular. These mussels have become celebrated through the Temple of Serapis at Pozzuoli, on the columns of which is seen a sharply limited belt, six feet wide, of holes made by the Lithodomus. The temple at some period sank below the level of the sea with a subsidence of the land, and was raised again subsequently.

The **Pinna** are large thin-shelled club shaped mollusks, which stick the pointed ends of their shells into the soft bottom of the sea. They also possess a byssus gland, which, however, is much larger and finer than that of the common mussel, and the threads produced were once manufactured into all kinds of fabrics. As late as last century factories might be found in Taranto, Naples and Sicily, occupied solely in manufacturing a sort of silk from mussel-threads: « the shining green bundle of threads was washed twice in soap and water and thrice in pure water, then immediately hatchelled, and spun on the distaff into a yarn of three threads, from which gloves, stockings and even whole dresses were made. »

Now and then pearls are found in the *Pinna*, but they are of no value. The ancient fable of the mussel-guard (*Pinnotheres*), which warned its host of approaching danger, and received a lodging in recompense, was founded on the fact that in almost all mussels is found a small crab, such as is also seen in the

ascidians, sponges and other low forms of creation; but it is of no sort of use to the Pinna.

If the creatures here described seem to be the embodiments of the principle of stability, the *cockle* and *scallop*, on the contrary, prove that not all the members of this family share in difficulty of locomotion.

The *cockles* or **Cardium**, are a genus with very numerous and diversified species, and take their name from the shape of their shell which is remarkable for its protruding spiral whorl, and radiating ribs, often set with spines. The animal has a long, rounded, bright-red foot, of which it makes a very peculiar use. Fixing it firmly on the ground, it stiffens it by swelling, and then bounds forward for several feet. This jumping is a very unexpected feat for a shellfish. The animal can also sink deeply into the sand with surprising velocity by rapidly extending and contracting its foot , the point of which being hooked serves as an anchor. Cockles are much prized in the market, and are caught in immense quantities on the English coast.

The *Scallop* (**Pecten**), the largest species of which is the **Pecten jacobaeus**, or pilgrim's scallop, has been used from old time to decorate the hats or cowls of pilgrims, and belongs to the best-known members of the whole group. It has one round and one flat valve with radiating ribs. On the thicker edge of the mantle are numerous short feelers and eyes, which can be seen when the valves are open, the eyes glittering like gems. They probably serve to guard the edges of the shell. This animal makes movements as surprising as the jumping of the cockle. It darts about in the water with arrowlike swiftness by opening and shutting its valves in quick succession ; as soon as the movements cease, the animal falls to the ground.

The most important and best known of all shellfish is the *oyster*, **Ostrea edulis.** Its irregular, flat, leafy and ugly shell, which is generally fastened by its thick side to some stone or piece of wood, is known to everyone. The animal itself effects the adhesion by means of a secretion that penetrates through the shell, and as the animal grows, the surface of adhesion is enlarged. The oyster is remarkable for the retrograde formation of its foot after it has fixed itself, and for being hermaphrodite, which is the case with very few shell fish. The same individual generates both the sperma and eggs. The number of the latter is enormous, and is calculated by many naturalists at several millions. The young oysters remain in the shelter of their parents' mantle until their shells are far enough developed for

them to fix themselves to some object. Spawning-time is in summer.

The geographical diffusion of the oyster is from 60° north latitude to the tropics and the southern hemisphere. On European coasts the oyster is the object of extensive fishery, and it is largely cultivated in special oyster parks, for it is not only an article of luxury, but even, especially in England and America, a national food. The ancients also cultivated oysters artificially. A century before Christ, according to Pliny, one Sergius Orata was the first to make an oyster-park on a large scale. The Romans of the Imperial age, on whose tables the oyster was never missing, considered those the best that came from Lake Lucrine, near Bajae. At Brindisi oysters were also largely cultivated as at Taranto now. In the middle-ages they were cultivated in England and Denmark. Now the principal oyster-parks are on the Atlantic coast (Arcachon, Ostend), and in the Adriatic. They are large stone-beds connected with the sea by sluices, and frequently cleansed. The oysters are *sowed* in these places and carefully tended till sufficiently fattened for the market. Natural oyster-banks, for instance in the shallow water of the coast of Holstein, yield a large supply.

The Sea-Squirts (Tunicata).

We stand before a tank containing a curious picture of *still-life*. Groups of white, half-transparent double-tubes, among which are scattered some rough lumps that look as if made of white glass or of wrinkled brown leather, are seen together with splendid red things shaped like a sack with funnel-like openings at the side and upper end. In one place lie lumps like greenish jelly, and the sides of the tank are covered with a varicoloured crust of starry pattern — all strange forms of which the inhabitant of the inland is entirely ignorant. These creatures hardly betray their inner life, and it is only when we attentively observe them that we see an occasional opening and shutting of the above-mentioned funnels.

This group, which resembles a bed of wonderful plants, is a riddle to all who have not examined the organisation and habits of the low animal forms comprised within it. Thus it is necessary to mention at least the most important facts relating to the structure and development of these animals; all the more because lately the Tunicata have played a great part in the scientific discussion as to the origin of the vertebrate animals, including man.

If we open one of the large white lumps (**Phallusia mamillata**) lengthwise, we see that the coarse external cartilaginous coat or mantle contains a second much more delicate sack, connected with the first in two places corresponding with the visible external openings. The external coat is principally formed of a substance very similar to the so-called cellulose, the membranous matter of vegetable cells and once believed to be it. The inner sack opens from the orifice at the end into a large cavity containing the gills, the sides of which are coated with a ciliated sort of trelliswork. At the bottom of this cavity is the true mouth, into which small particles of nourishment are conducted together with the water, by means of the action of the fringes of the gills. The intestines, which are wound into a kind of ball, lie, together with the organs of circulation and generation, at the bottom of the inner sack, and the excretions are emptied through the lateral opening in the body, which also serves as a duct for the products of generation and for the ejection of water from which the air is exhausted. A nerve-ganglion, with radiating nerve-fibres, lies near the orifice into which the fresh water is received.

The Ascidians, a group of the Sea-squirts, are almost all adhesive animals, and either remain *single*, like the above-mentioned Phallusiae, which are generally the largest species, or they form colonies in which the individuals are connected by roots (*social Ascidians*, for instance **Clavellina**). The *composite* Ascidians form a third group. These animals are imbedded in a common sack and arranged in a certain manner. To this group belong the rind-like crusts seen on the rocks of the tank, in which one can distinguish with the naked eye the pretty little round animals, like rosettes, gathered round a common excretory vent. Till now only one kind of unattached swimming Ascidian is known, the **Pyrosoma**, a hollow gelatinous tube, shaped like a fir-cone, upon which the single animals stand up like the little pegs on the barrel of a musical box. They belong to the pelagic animals which cause the beautiful phosphorescence so often observed in the sea. This creature is very seldom found in the Aquarium, for it is one of the rarest and least unterstood animals in the Gulf.

A discovery made by the Russian zoologist Kowalewsky has connected the history of the generation of the Ascidians with that of the origin of the vertebrate animals. That naturalist observed that from the eggs of the ascidians were developed unattached swimming larvae provided with a moveable oar-tail

and temporarily with an organ that, in its position, had the greatest resemblance to the *corda dorsalis*, or spinal-chord of the vertebrate animals (fishes, reptiles, birds, mammals, and such like). This organ is an elastic cartilaginous string, along which, in the animal in question, is laid the spine and its marrow, and which, in the lowest form of the vertebrates, the *lancet fish*, **Amphioxus**) remains for life, but is lost in the larvae of the Ascidians during the retrograde transformation by which the unattached larva becomes a fixed ascidian. The conclusion drawn from these facts is in harmony with the scientific theory according to which every individual, during development, passes through a series of forms inherited from its ancestors during the course of the earth's history. Just (to choose a more familiar example), as it is deduced from the fish-like shape and organisation of the tadpole, that fishes were the ancestors of amphibians, or, which is the same thing, that frogs originate in fish-like vertebrates; so, from the temporary appearance of the spinal-chord in the larvae of the Ascidians, it is deduced that these animals are connected with the vertebrates by a common original form. This theory, however, cannot yet be regarded as a scientific fact, the difficulty of examination being so great; and lately another theory has been opposed to it, according to which the ancestors of the vertebrates are rather to be looked for in animals like the higher worms or annelids in the Aquarium.

All the Ascidians are hermaphrodites, that is animals which unite both sexes in one individual. Besides sexual generation which produces unattached swimming larvae from impregnated eggs, there exists in this group an unsexual generation by budding, to which the *colonies* owe their origin.

Opposed to the Ascidians as adhesive or attached animals, are the *Salpae* as swimming animals. Their delicate transparency shows them at once to be pelagic animals, which, like jelly-fish, live in the open sea, and are carried, together with the other representatives of the pelagic world, by winds and currents to the coasts, where they are often caught by thousands in the fishermen's nets,-a very unwelcome catch indeed.

All the year round, but especially in Spring and Autumn, salpae are brought to the Aquarium, where, like other pelagic animals, they are exposed in separate glass vessels. It will not be difficult for the spectator, guided by the following remarks, to make himself acquainted with the general construction of a

salpa, especially if he have before him one of the larger kinds, for example, the **Salpa maxima Africana.** The outer part of the long barrelshaped body forms, as in the Ascidians, a tunic or sack, at each of the two ends of which there is a large orifice. The animal swims with its fore-end first by taking up water through the front orifice and letting it stream into the hollow of its body, across which the gills are stretched like a ribbon. As soon as the body is filled with water, the front orifice closes, the muscular girdles that span the body contract, and at one stroke drive the water out of the back orifice, thus impelling the animal forward, which, one might say, moves by swallowing. Near the hind-part of the body is noticed a round reddish-brown organ, the *intestinal-ball*, which is led to by a mouth-orifice situated at the bottom of the cavity containing the gills. In front of the intestine lies the transparent gourd-shaped heart, which, in this animal—a remarkable fact—contracts alternately in diverse directions, so that the circulation of the blood is periodically reversed.

The development of the Salpa is of great interest for naturalists. The poet Chamisso, who was at the same time an enthusiastic zoologist, observed during his journey round the world that in the Salpae "the daughter never resembled her mother, but her grand-mother," as he expressed himself; that is, that in one species two different forms regularly alternated, the first consisting of a chain of several salpae, while the second consisted of independent individuals. Later research has entirely confirmed this "change of generation" in the salpae, and discovered new details. In the Aquarium are frequently to be found both chains and single salpae near together; the first are often of considerable length, or strung into a wreath. All the members of such a chain are exactly similar in structure, and develop into hermaphrodites. From their eggs, however, issue not chainsalpae but separate individuals, which are distinguished from their parents not only by certain differences of structure, but also by the fact that they never produce eggs. Instead they generate, on a special germ-stock in the vicinity of the intestinal-ball, interior buds, which are seen, even at a very early stage, to be little chain-salpae, and are born as such so soon as they attain a certain size. The germ-stock produces several of these chains. Like the Pyrosoma among the Ascidians, the Salpae also belong to the phosphorent animals, and it is from the intestinal-ball that the most brilliant light radiates.

Fishes.

Fishes, the only vertebrates (with the exception of the tortoises) that we have in the Aquarium , are distinguished by such well-known characteristics , that , nothwithstanding the variety of their shape, they will hardly ever be mistaken for members of any of the other large divisions of the animal kingdom. Neither the mollusks and crabs , nor the worms , sea-urchins, or corals, have forms resembling those of fishes, and. having remarked that the falsely so-called *inkfish* — sepias, calmars and such like—are not fish, but mollusks; and that the snake-like eels, flat soles and roaches, are true fishes, we think that we have resolved all doubt as to what is a fish and what not, for all other examples are at once recognised.

As the fishes in the Aquarium, like the other animals, are not arranged in systematic sequence, but according to biological principles , in which similarity of habits and habitat are the chief things regarded, so as to offer to the animal in confinement environments as natural as possible; — we think that we ought to adhere to the same arrangement in our descriptions. We begin, therefore — keeping separate the two large divisions of the bony and the cartilaginous fishes—with those of the bony fishes that pass their lives at the bottom of the sea , where they lie in ambush for their prey, half buried in the mud or sand, and very seldom, and that awkwardly, swim about. We include these fishes under the head of *ground-fish*. To these belong : The *Star-gazer* (**Uranoscopus scaber**), an ugly, muddy-brown fish, with a thick clumsy head and wedge-shaped body diminishing towards the tail. Its small dull eyes are placed far back on the skull , and like the bow-shaped mouth, turned upwards. It lies almost always buried up to the head in the sand , and amuses the hours of patient waiting by a peculiar sort of game. That is, it protrudes and waves about a long worm-like ribband or tongue which grows within its lower jaw. This strategem decoys the little fish playing near, who, trying to catch what they believe to be a worm, are pounced upon and seized by the greedy Star-gazer. When this fish is disturbed it swims about and moves its broad caudal fins like a pendulum, at the same time frequently putting out its tongue. In a few minutes it falls plump to the ground; and immediatly buries itself in the sand by the shovelling movements of its pectoral fins. It pursues the same manner of life in its

natural place in the muddy shallows of the sea. It is very frequent in the Gulf of Naples and is found in the market, though very little prized.

A similar picture is afforded to the visitor by the *weevers*, **Trachinus**, of which many species, the **T. draco**, the **T. vipera**, and others, are to be found in the Gulf. These are slender fish, pressed sideways, with metallic-blue, lively eyes, and spiny dorsal fins and gill-covers. When brought into the Aquarium they fall to the ground as soon as the first excitement is over, and in a few seconds are buried in the sand, nothing remaining visible but their eyes and mouth. When fed, they dart with equal rapidity from their concealment and snap up their food (little dead fishes) before it falls to the ground. At the same time, and also when excited, they erect their fins, the spines of which are rightly feared, for a wound caused by them often results in violent inflammation, and for this reason the fishermen handle these fish with caution, and break off the spines before carrying them to market. Perhaps the brilliant eyes of these fish, which, like those of the chamelion, can move in different directions independent of each other, serve as a decoy in a similar manner to the tongue of the Stargazer.

This principle of a decoy-apparatus is interestingly carried out in the *Devil-fish* or *Angler* (**Lophius**), probably the ugliest monster of a fish to be found in the Mediterranean. Almost three fourths of its body seem to be absorbed by its flat monstrous head and enormous mouth, the grinning jaws of which show a row of hooked teeth. Clothed in a dirty-brown skin, this beast lies half-buried in the sand, and stares upward with its dull and glassy eyes, the fringe of barbels on its chin flapping at every breath it draws. Sometimes it elevates its foremost reversed, flexible dorsal fins and lets the fringes at their edges play in the water as bait. Thus the Devil-fish is a living angle, its little barbels and fringes being so many decoy-baits for curious fish, and its gigantic mouth, always ready to close with a snap, a trap from which there is no escape.

This creature lives in the mud in the middle deeps of the gulf, and often reaches an immense size. Unfortunately it cannot endure confinement, for it refuses all food, and seems to be unable to exist out of the gloomy retreats of its natural habitat. The visitor therefore will not always find a specimen of this fish in the Aquarium, particularly as the larger examples seldom reach the Station alive.

In the same tank with the Star-gazers and Weevers, will

almost always be found several examples of the soles. The *side-swimmers* or *flat fishes* (**Pleuronectidae**) to which the soles belong, are a very singular group. Their bodies are twisted sideways from right to left, and the head so turned that both eyes are on the same side. Then the two sides are entirely different in colour and skin, for the one turned downwards is white, like the bellies of many other animals, while the upper side, on which are the eyes, is always of a dark colour, and has, besides, the power of changing its colour to that of the ground. Many of these fish can imitate the white pebbles strewn in the grey sand, by causing similar light spots to appear on their dark skins. This power of imitation greatly protects the fish, and it is not always easy to see them in the tanks. They are first betrayed by their protruding opalescent eyes, which they can move singly in all directions and thus command the whole neighbourhood. The sole catches its prey, consisting of the smaller fish that also live on muddy bottoms, by impelling its body forward with lightning-like rapidity. The sole swims very actively, gracefully undulating its flat body, and always turning the side on which are the eyes uppermost. When it wishes to bury itself a few strong strokes with its dorsal fins are sufficient to throw up a quantity of sand which falls back upon its body; when it again lies on the watch, immoveable for hours together.

Flat-fish increase in an extraordinary manner, which fact is partly explained by the natural protection afforded them by their power of imitating the colour of surrounding objects. They also form a large part of human economy, for all kinds have excellent flesh not easily spoiled, and can therefore be imported far into the interior. Many kinds attain an enormous size. In consequence, they are an important article of commerce in the North. Germany, England, France, Holland and Denmark consume immense quantities. Imports to the value of 80,000 pounds sterling are annually brought to London alone from Holland, and this is at most the fourth part of what that city consumes. In Italian markets flat fish are among the commonest and most highly prized. They are fished in different ways, sometimes with the harpoon and drags, sometimes with the angle and ground-lines.

The principal flat-fish are the turbot, sole, flounder, plaice and dab. Only the smaller kinds can be accommodated in the Aquarium; the *Sole* (**Solea vulgaris**), the *Turbot* (**Rhombus maximus**), and similar kinds are usually to be found.

From these ground-fish, in the strictest sense of the word, there is only a step to such fishes as select the crevices and hollows of rocky coasts for their place of abode, when they usually lie in wait for prey in a similar manner to the fish before described. To this class belong the curious *Dragon-heads* (**Scorpaena**), clumsy fish with thick heads and big mouths, large spiny fins and peculiarly developed skin-appendages, in the form of little ragged, feathery leaves and spines. These fish jam their bodies into the corners of the rocks, and can so exactly imitate the colour of the rocks that any one not aware of this power may stand some time before a tank full of Scorpaenae before seeing one. In the dark corners, many resemble a fragment of rock overgrown with delicate plants so perfectly, that this faculty alone must to a great degree protect them from their enemies and enable them to surprise their prey. We find this principle of protective imitation in a great number of animals ; it is so with the inhabitants of the desert, which are almost all yellow like the sand; and with the white polar and alpine animals , some of which — for example the Snow-hen, — even change their coat according to the season. It is so with the transparent Medusae and pelagic animals of the ocean, whose transparency protects them from pursuit. In some animals, the principle is carried out by their resemblance to plants, or to animals better protected than themselves, either by weapons or poisonous glands , or by their insignificance. Certain flies imitate the habitus of bees and wasps, and tropical butterflies imitate those of their relations who are better prepared than themselves for the struggle for life. This interesting phenomenon is called " mimicry, " and it has been proved to exist in marine animals of very different classes. It is a striking proof of the theory of the gradual transformation of animals and vegetables by natural selection of better organized forms.

Akin to the Dragon-heads, in its manner of life, is the *Goby* (**Gobius niger**), a little black ground-fish of clumsy form, which always lies at the bottom of the tank, usually in some rocky cavity, a bunch of algae, or such like. It is, however, fonder of moving than the Scorpaena. In the sea , during spawning time, it leaves its hiding-place and digs a roomy dwelling among the roots of the sea-weed, in which it drops its eggs. The male is the architect, and lies at the entrance of the nest, enticing the female to approach. When the latter has laid her eggs , the male immediately impregnates them,

and later on guards the brood for about four months, courageously defending it against every foe. When the female has made numerous visits, the nest is enlarged and provided with several exits. During the spring-months the laying of the eggs, and their bold defence by the male, may very often be observed in the Aquarium.

The numerous varieties of *mudfish* (**Blennius**) are small, bold, voracious fish, which, in spite of their awkwardness in swimming, are very lively. They inhabit the algae-grown regions of the rocky coasts in shoals. They may be seen pursuing each other among the rocks and sea-weed. When danger approaches they disappear into some corner quick as lightning. They are very curious, tasting everything that comes in their way, and they molest all inoffensive animals. They tear off the heads of the annelids, attack the eyes of crabs and fishes, and pull the anemones till they die.

The largest and most beautiful of this species is the *Butterfly fish* (**Blennius ocellaris**), which has large erectable dorsal fins with a dark blue spot in the middle.

Passing from these ground fish to those which move freely through their crystal element, we come first to some good swimmers, who, however, still cling to the bottom of the water and near the coast, where they sometimes remain quiet and sometimes swim about. Of this class many species of *Gurnards* (**Trigla**) and *Flying-gurnards* (**Dactylopterus**) live in the Gulf. The first are distinguished by a peculiar growling noise which they make when taken out of the water. This noise is produced by the friction of certain parts of their hard gill-cases against neighbouring parts. Their movements when on the ground are also curious, for they run along on the ribs of their pectoral fins, which are unconnected by any skin, like crabs run on their legs. These pectoral fins are like splendidly coloured wings, and by their aid the fish can spring out of the water. They are very voracious, and have enormous mouths.

The *Flying-Robin* (**Dactylopterus volitans**) is a beautiful creature, which uses its strongly developed pectoral fins like real wings. These fish live in swarms sometimes creeping on the ground, at others swimming about in all directions. They rise with a noisy beating of their fins to a height of sixteen feet above the surface of the water, and after a flight of some 100 feet, fall back, to repeat the same sport. Frequently several swarms follow each other, and are seen rising and sinking in rapid sequence. When such swarms take a decided direction

it is certain that they are pursued by some enemy. In the neighbourhood of the coast they attract sea-birds, which hunt them from above. They are less persecuted by men, for their flesh is hard and tasteless. When taken they also growl like the Gurnards. In the Aquarium they are only periodically seen.

In similar swarms the *Red mullet* (**Mullus barbatus**) frequents the muddy bottom, rich in animal organisms, of the ocean, where they eagerly seek for food with the two sensitive barbels on their jaws. In the Aquarium one can observe the play of these two feelers; sometimes they slowly and carefully search the mud, and at other times move with great rapidity in all directions, or are drawn back into the folds of the jaws. The Red Mullet was highly prized by the Romans, and incredible sums were paid for a large fish. Seneca and Juvenal relate that some were worth from 6 to 8000 sestertia. The fish were also presented alive in glass dishes to the guests, and allowed to die in the hands of women, who delighted in watching the beautiful play of colour on the scales. The red-mullet is still highly valued in all Italian markets, but is not very dear.

As an inhabitant of the rocks, we have still to mention the *Eel*, of which species the great *Conger-Eel* (**Conger marinus**) and the *Muraena* (**Muraena helena**) are to be found in the Aquarium the whole year round. The other species frequenting the Gulf, such as the **Conger myrus** and **Ophisurus**, are rarer guests, and only occasionally to be found. In the tank containing the eels and muraenae, these creatures are found in various situations; some swimming about with beautiful undulations of their bodies; others lying half hidden in vessels and jars placed in the tank on purpose, only their heads and rapidly breathing gills protruding from the orifices. In a natural state the crevices of the rocks serve as similar hiding places. The conger-eel is a gluttonous fish which often attains the enormous length of more than ten feet, and even in the aquarium, owing to its phlegmatic habits and excellent appetite, it becomes a splendid example of the species. It is very soon tamed, learns to take food from the hand of the keeper, and never refuses the young of its own species. It is common in the market and not dear.

The Muraena is distinguished by the beautiful marking of its body and the absence of pectoral fins. It amiably shares the jars with the eels, and we often see two or three animals in the same vessel, so that it is difficult to understand how

they find room. Its beautiful snake-like motions, splendid colour, high dorsal-fins, and the expression of its head, with glassy eyes and wide-stretched jaws, give the Muraena a very peculiar appearance, which involuntarily attracts the attention of the spectator. It is well known that the Romans considered these fish a great luxury, and built large tanks in the sea for them, so as to have a supply always on hand. Pliny relates that a certain Hirius, on the occasion of Caesar's triumphal entry, laid before his guests 6000 of these fish. Crassus possessed a large muraena, of which he was very fond; he put a golden collar round its neck, and is even said to have wept when it died. It is told of Vedius Pollio that he punished several guilty slaves by throwing them as food to his muraenae, having heard that human flesh made those fish very delicate eating. At present the Muraena is highly valued, and there is a large market for the fish at Pozzuoli. They are caught in baskets or with the line. At such times they offer violent resistance, biting savagely, and, being very slippery, are difficult to hold. Fishermen are afraid of their bite and think it poisonous, but no doubt it is only the shape of their sharp and crooked teeth that produces wounds difficult to heal. They endure confinement in the tanks of the Aquarium for years together, and like the eels, can be tamed to a certain degree.

Very curious little animals, not only among ground-fish, but any fish, are the *Sea-horses* and its relations, which under the name of *Lophobranchii* are classed in a particular division. Almost everyone who has visited a marine town is acquainted with the common Sea-horse (**Hippocampus**) which is found dried in the fish-markets, for its case or coat is so hard that the shape remains almost unchanged. The habits of this little creature, which is common in the Gulf of Naples, are extremely attractive; everything about it is strange, even its shape, which closely resembles that of a chess-knight. They are best off when kept in a tank where branches of corals or tube-dwelling worms afford points of support around which they can cling, according to their habit, with their finless, prehensile tails. The tank containing the worms is therefore appointed for their habitation. Here they may be seen in all possible positions; swinging on the stems of the worm-tubes, and looking about with their small quick eyes for the minute animals that people the outside of the tubes. When they swim they rapidly move their little fins, and float up and down with graceful movements, turning and bending in all directions, either pursuing

each other or swimming in pairs, at the same time twisting their tails round each other and playing all sorts of pretty tricks. In pairing time (autumn) their motions are very lively, and a couple are often to be seen swimming about and caressing each other or hanging in loving companionship on the tube of some marine worm. The manner in which they nurse their progeny is equally curious. As soon as the female lays her eggs they are received by the male, who carries them about with him in a pouch under his tail until the little things are capable of independent existence. When their lively movements begin to irritate the male, he endeavours to rid himself of them, repeatedly bending his tail near the place where the pouch is. At every bend he makes the pouch opens, and a number of the little animals, which look like notes of interrogation, escape and immediately begin to swim about; they are then about half an inch long.

The sea-horses are of no importance whatever to mankind, and it seems that they have few or no enemies in the sea; at least in the Aquarium, where they are kept together with all kinds of animals, they remain entirely unmolested. Other kinds of Lophobranchii are the *Sea-needles* (**Syngnathus**, **Nerophis**, and **Siphonostoma**). The last inhabits meadows of seagrass; and in form and colour imitates to perfection the decaying leaves (mimicry).

The true swimming fish to which we will now turn our attention, are principally the kinds familiar by their shape even to the non-scientific visitor. They spend the greater part of their lives in swimming or floating, thus proving that they are more or less master of the element in which they live. Yet even some of these are, by habit and the food they eat, bound to the configuration of the coasts, and there have their settled abode; while others rove more freely through the ocean, especially the pelagic fish, and are entirely independent of the shore or the bottom of the sea.

We will first notice the coast fish and, before all, the *Wrasses* or *Labroidae*, a species distinguished for splendour of colour reminding one of the tropics, and deriving their name from their thick protrusive lips. To this species belong the gay **Labrus** and **Crenilabrus**, and the smaller **Julis**; all lively fish that frequent precipitous coasts rich in algae, and are to be recognized by their peculiar way of swimming by starts. Of the first-named and larger kind the pretty **Labrus festivus** is very interesting from the care which it takes of its young,

and the bold defence of them by the male. The small *Julis* (**Julis Giofredi, vulgaris** and **turcica**) are as pretty and swift in their motions as they are richly coloured, and a great ornament to the Aquarium. The voracity with which they fall upon anything that is thrown to them, and their impudent curiosity, are very amusing. They fight hard for every morsel, and each tries to snatch a bit with his pointed and fine toothed snout. They glitter splendidly in the sunshine, their eyes shining like jewels. They are very sensitive to a low temperature, and every evening go to bed in the sand at the bottom of their tank, so that a night-visitor to the Aquarium will only see here and there some small head protruding. On cold winter days they also remain buried in the sand, and at all times, if in danger, disappear like lightning. The larger kinds of Labrus and Crenilabrus may often be seen resting against some rock, a habit in which there is still a trace of the ground-fish.

Similar to these is the *Razor-fish* (**Xyrichthys novacula**), which conducts itself exactly like the *Julis*; and the small *Monk-fish* (**Heliastes chromis**) which haunts steep coasts in sociable troops.

Contrasted with the liveliness of these smaller fish, is the phlegma of the *Sea-perch*, the largest of which, *Giant-perch* (**Serranus gigas**) is not only the most majestic, but also bears confinement best. This fish delights in floating for hours in one spot, generally near the stream of water which runs into the tank; sometimes it places itself immediately beneath the stream in a vertical position and allows the fresh aerated water to pour into its wide open jaws and gill-covers. When alarmed it darts away under some arch in the rock-work, and with equal rapidity rushes at its prey, which it unfailingly catches. Its whole behaviour proves it to be a prudent, retiring creature, fond of safe hiding places. Under the name of *Cernia* this fish is one of the finest table-fish in the Italian market, and commands a high price.

The little *writing-perch* (**Serranus scriba**) so called from the marks on its gill-cases which look like handwriting, is distinguished for its beautiful colour and resembles its relatives. This species belongs to the few hermaphrodites found among fishes.

Much more lively than the above fish are the *wolf-perches* (**Labrax lupus**) which traverse in company the largest tank in all directions. The wolf-perch is a voracious fish found both in the Atlantic and the Mediterranean. The ancients were well

acquainted with this fish. It often attains a length of more than three feet, and is one of the finest table fish (Branzin, Spinola). It usually haunts the coast, for it prefers shallow water, and often enters the mouths of rivers. In stormy weather perches approach in shoals in order to catch the mollusks torn from the rocks by the breakers. They are caught with the line, and the larger kinds offer violent resistance when taken. In the Aquarium they live and propagate for years, but till now the young have never fully developed.

To the commonest fish in the Gulf belong the different species of the genus **Mugil** (*mullet*). They are easily recognised by their slender silver-grey bodies and the peculiar form of their mouths; the thick upper lip has a gap into which fits a protuberance on the under-lip. These fish come near the coast in shoals, and chiefly feed on soft, decayed material. In the Aquarium they prefer the algae and slime which cover the rocks, and decayed animal and vegetable matter, so that they are very useful as scavengers. Their flesh is very good and tender, and, being also plentiful, they are one of the commonest table-fish (Cefalo).

Many fish of the same kind are almost always to be found in the Aquarium, but so little is known of their habits, when in their natural state, that it is scarcely possible to enter into detail, so we will be content with mentioning their names, adding a few remarks to the most interesting. First are the different species of *Bream*, which, having well-tasting flesh, are largely fished and highly valued in the market. The *sack-bream* (**Pagrus**), *red-bream* (**Pagellus**), *gold-stripe* (**Box**) and similar small kinds live together in one tank, and feed on small crabs and other animals; also on vegetable matter. Then come the larger *goat-bream* (**Sargus**), *snout-bream* (**Maena**), and the rarer *black-bream* (**Cantharus**), which has hitherto been represented in our tanks by a single individual that has lived there for several years and is the oldest fish we have. The most valuable are the *gold-bream* (**Chrysophrys**) and *tooth-bream* (**Dentex**), very beautiful fish, with shining marks on their round backs. The first is caught in all parts of the Mediterranean, and also in brackish inland-seas and lagoons, where they go to hunt shellfish, for which reason the latter are used as bait in fishing. The Romans cultivated these fish in ponds and in Lake Lucrine. The *tooth-bream* is the largest of all, often attaining a length of three feet, and weighing more than 20 pounds. These fish are terrible brigands and often snatch fish

out of the very net. In the Aquarium they are very lively, and fond of swimming in company.

Compared to the glittering breams, the *Sea-raven* (**Corvina nigra**) is remarkable for its dark brown colour. It is a peaceable fish, always keeping close to its fellows, and, head downwards, seems to be thoughtfully examining the bottom of the tank.

Of the *Plectognathi*, so rich in strange forms of a tropical character, which may be known to the visitor in the globe-fish seen in Museums of Natural History, we are acquainted with only two species that inhabit the Gulf of Naples: the *moon-fish* or *swimming-head* (**Orthagoriscus mola**), and the *balista* (**Balistes capriscus**). The first is, till now, one of the greatest rarities in the Aquarium, and scarcely ever outlived its imprisonment more than a few days, so that we can report nothing interesting as to its habits. We have become much better acquainted with the *Balista*, of which we have always specimens from spring to autumn. This fish is full of interest. Its very shape, its one sided and out of all proportion short and thick body, at once excites attention, and its brilliant blue eyes, as well as its narrow pointed mouth armed with a few closely-set incisors, heighten the singularity of its appearance. It is a lively, curious, sociable fish, which, however, only fully shows its nature during the summer months, for it is very sensitive to cold, and regularly sinks to the bottom of the tank when winter commences. It lives on shell-fish and crabs, which it breaks with its powerful teeth, making such a noise in doing so that it can be heard through the glass of the tank. It snatches food from the very jaws of the large tortoises that share its tank, and attacks the eyes of lobsters and craw-fish, so that these animals cannot be kept in the same tank.

The Balistae have given us a few remarkable proofs of their power of discrimination, which may be briefly related here. One day a dying shark (**Carcharias glaucus**), about five feet long, was put into the large tank containing the Balistae, where he died a few minutes after. Scarcely did the Balistae catch sight of the animal when they fled in mad fright, and hid in the darkest holes and crevices of the rock-work, whence they cast shy glances, changing their colour the while, on the dying monster. They had recognised their deadly enemy at a glance, and showed their terror in—for fishes—an extraordinary manner. Another case was that of a single Balista which the keeper had repeatedly tried to catch, in vain. Each time it slipped into

a certain hiding-place. Whenever it saw the keeper appear with his net above the tank, it retreated to its corner, while other people it regarded with the greatest calmness and curiosity, swimming about on its side at the top of the water.

We have now arrived at the true pelagic swimmers , the *mackerel*. Like the storm-birds and frigate-gulls that spend their lives suspended above the immeasurable plains of ocean, these fish traverse the high seas, only approaching the coast periodically, when (like the tunny) they become the objects of extensive fishing. — All attempts to introduce these shy and sensitive fish into the Aquarium have failed. We shall never be able to keep either the tunny or its nearest relative, the *sword-fish*, in our tanks, for they cannot endure the slightest abridgment of their liberty. They all become frantic and die within a few hours , and only a little fork-mackerel , the *beater* (**Lichia glauca**), has, like the Balista, become a regular summer guest in the Aquarium. It is an extremely pretty fish, with its slender body shining like pure silver, and its restless activity.

A pelagic fish akin to the true mackerel, which roves solitary in the high seas and is seldom brought to the Aquarium, is the *St. Peter's fish* (**Zeus faber**). It derives its name from the legend that out of this fish's mouth St Peter took the piece of money; the people say that the two dark spots on its sides are the impression of the saint's fingers. It swims slowly about, waving its large fins , but refuses all nourishment, and soon turns on its side and dies. It is valued as food in all European markets.

The second order of fishes of which we have yet to speak, includes the cartilaginous fishes to which belong the *sharks* and *roaches*. Of this group the Aquarium contains almost exclusively the ground-fish, which reveal very little of their habits to the visitor. We will therefore chiefly confine our description to the pecularities of their organisation and development, and only in the second place mention their very monotonous habits. Let us first take the sharks.

The mention of this name usually arouses in the non-scientific listener the idea of those sea-giants that are the horror of sailors and all inhabitants of the coast. He is therefore no

little astonished when told that a fish in the Aquarium, scarcely three feet long, is a *shark*; and probably imagines it to be a young, or "false" shark, We must therefore remind our reader that the chief characteristic of the species is not gigantic size, but a peculiar organisation; and that, excluding young ones, there are very small varieties of the species shark, which have all the peculiarity of construction common to the large varieties. In order to understand this peculiarity, as far as visible in the living animal, we beg the visitor to look attentively at one of the spotted cat-sharks that usually lie in a corner close to the glass of the large tank, and compare it with one of the large perches. The perch has the typical scaly body, dorsal, pectoral and anal fins, symmetrical tail, large moveable gill-coverings, with the leaves of the gills beneath lying in rows fastened to a bony arch, and mouth situated at the point of the head; it has further lidless and glassy eyes, and small nostrils. The shark, on the contrary, has no scales, but has a rough skin like chagrine; its tail is unsymmetrical, one side being long, the other short. Its mouth is a large slit, set crosswise *under* the head, and its gills are fast grown to the sides of certain pouches which lie one behind the other, and are led to by a row of five or more openings in the skin of the neck. Its eyes have lids which can close, and its large nostrils are distinguished by flaps of skin. The skeleton of the shark is cartilaginous—not bony—and the skull is a gristly capsule. These characteristics are common to all sharks, both large and small, and by them even an unpractised eye at once recognises the genus as entirely different from all bony fishes.

The shark which we take for an example, belongs to the genus **Scyllium**, of which two kinds, the **Sc. catulus** and the **Sc. canicula** — *cat-shark* and *dog-shark*—are found all over Europe. The first attains a length of three to three and a half feet, the latter only one and a half to two feet, so that this one belongs to the smallest variety. They are lazy fish which hunt their prey at dusk and in the night, and during the day generally sleep in a corner of the tank, rarely swimming about. In the daytime they seek their food by scent, for at that time they are half blind. They go smelling all over the bottom of the tank, with graceful motions of their spotted bodies, and it is only when they touch it with their noses that they find their food. They are little less gluttonous and impudent than their larger relatives, and their well-armed jaws can master immense pieces. We have become thoroughly acquainted with their

manner of propagation. The female deposits her eggs on coral branches, or on plants or rocks. The eggs are single square, horny, transparent capsules, which are first white and then turn into a yellowish brown colour; they have at each corner long twisted cartilaginous strings similar to cat-gut, by means of which the female fastens each egg to some object, and to effect this, swims round and round it while the egg is being ejected from her body. This hanging-up of the egg is meant to preserve it from being covered by mud or sand, which is the greatest danger to which it is subject, except that of being destroyed by the animals that live in the sand. The development of the germ in the egg can be well seen through the transparent shell. The so-called germ-spot first develops on the oval yolk, and gradually over-grows and becomes separated from it. Later on one can recognise the form of the little fish which is transparent as glass, and has on each side of its neck a bunch of exterior gill-threads (temporary embryonic organs). It is connected with the yolk-bag by a long string which conducts the nourishment into its intestine. The lively undulating movements of the slowly growing little animal can now be seen; by-and-by the gill-threads are absorbed, and later on, the colouring and spots on the skin of the young fish gradually appear and increase in distinctness. When the young one is ready to escape from its prison, and has consumed all the yolk, it pushes itself head-first through one end of its eggshell where the flakes are more loosely connected, and swims actively about, dragging after it the remains of the yolk-bag. The eggs and embryos are often to be seen in the Aquarium, for not only as the Scyllii of the large tank pair and deposit their eggs on rocks and branches, but fishermen also bring pieces of coral and similar objects hung with shark-eggs. Just lately these embryonic stages have become very important to science, and comparative anatomy has very often profited by the rich material afforded by the Zoological Station. The use of the Scyllii from an economic point of view, is very small. Their flesh is bad, and only eaten by the very poor; the skin is used for polishing, the liver for preparing oil. They commit great ravages among herrings in the northern seas.

The *smooth shark* of Aristoteles, **Mustelus laevis**, is far less often found in the Aquarium than the cat-shark, for it can scarcely endure confinement. It is one of the most harmless of the race. Its blunt teeth oblige it to feed on mollusks and other soft animals, which it finds in the deep sea. When

brought into a tank, it first swims rapidly about with beautiful undulating motions of its silky body, but very soon grows faint, and at last can no more rise from the ground, and refuses all nourishment. The propagation of this fish is very interesting, for it is one of the sharks that give birth to living progeny. The embryo develops by means of a so-called *yolk-bag-placenta*, that is, there are formed on the surface of the yolk numerous little protuberances that fit into corresponding depressions on the sides of the womb, and thus a connection is maintained between the mother and the fruit similar to that known in the mammalia. There has been frequent opportunity in the Aquarium to witness the birth of from fifteen to twenty young ones.

Another fish that bears living young, and forms the transition from sharks to roaches, is the *Sea-angel* (**Squatina angelus**); a large mishaped fish, which like the flat fish, lives always on the ground, and is often taken for dead by the spectator. The sea-angel is one of the dullest and laziest fish in the Mediterranean, and feeds on what it finds living at the bottom of the sea. When disturbed it swims pretty quickly, end shows the wing-like shape of its pectoral fins, from which it derives its name. Poor people eat its bad flesh, and its skin is manufactured into rasps, knife-handles, sheaths, and such like.

The real *roaches* have a flat body shaped like a plate and all on one side. On the upper side, which is dark coloured, are the eyes and two spouting holes that lead to the gills. The long thin tail is usually spiny. They are all ground-fish, and, like the sea-angel, live on the fish that inhabit the same region.

The most interesting variety is the *electric ray* (**Torpedo**), the electric power of which was known to the ancients. Its flat, naked, slimy body is nearly round, and contains on each side a large bean-shaped electric organ, consisting in numerous vertical six-sided columns of a gelatinous substance, in which a number of nerve-fibres, originating in the spinal-marrow, end in peculiar organs called *nerve-end plates*. The nervous electricity is collected in this apparatus and discharged when the fish is touched. The back is positive, the belly negative; and in order to receive a shock the visitor must touch the fish on back and belly at once. The effect is considerably weaker than in the South-American electric eel, but in a large fully developed fish, is painful enough. After repeated discharges, the strength of the shock decreases. This organ is a wea-

pon of offence and defence, the fish killing or at least paralysing its smaller prey by its means.

The electric ray bears living young, sometimes eight to fourteen at one time. It is one of the commonest fish in the Gulf, and, in spite of its bad flesh, is often found in the market. It lives very well in confinement and there is always in the Aquarium at least one fish placed in a small open tank for visitors to experiment with.

Many other kinds of rays live in the tanks of the Aquarium; for example, the **Raja**, and the *thorny-ray* (**Trygon**), but the last is rare. The first have a rhombic body of a brown colour, and a thin prickly tail. The Trygon is violet-black in colour with a wing like extension of the skin and long thin tail. On this tail there is a spike said to produce dangerous wounds.

We must still mention, while speaking of fishes, the remarkable *lancet-fish* (**Amphioxus lanceolatus**), which has been so much talked about of late years, and which is considered to be the smallest and simplest form of vertebrates. This little fish scarcely two inches long, and almost transparent, has no fins, no bones, and no brain. Instead of a heart it has only some pulsating vessels filled with colourless blood, and in its remaining organic system, shows such a primitive formation, that the species has been separated from true fish and placed in a peculiar subdivision (tube-hearts, skull-less fish). But far more on account of its manner of development than on account of its bodily construction, this animal has attracted the attention of zoologists, for the first stages of that development have the greatest resemblance to those of the Ascidians. The Amphioxus is therefore considered to come next to the original form of the vertebrate animals. Another theory sees in its low organisation the result of a retrograde development, and points to its habits, for it leads a light-shunning existence in the shallows of sandy coasts, and rather resembles a mud-inhabiting worm than a fish. It is found by thousands in sandy places on the shores of Posillipo and similar localities on the Gulf, and has also been proved to exist in the German Sea and the Ocean (South-America). It can only be kept in the Aquarium when provided with a quantity of sand in which to bury itself, and it only issues forth at night or when disturbed.

Besides the fishes, we have one reptile in the Aquarium, the *Couana* (**Thalassochelys corticata**), a Mediterranean

sea-tortoise which sometimes attains a length of four feet, and weighs as many hundred pounds. It is frequent on all Mediterranean coast, and is found in the Adriatic as far as Trieste, and also in the Atlantic coasts of Europe. It lives on crabs and other small animals, and when newly caught defends itself bravely. Its mighty jaws are a weapon by no means to be despised. Even in confinement it continues vicious and ready to bite for some time. The tortoises in the Aquarium have often fought furious battles so that it has been necessary to separate them. In winter they become torpid and lose their appetite. They are of very little value, for their flesh is tasteless and their shell useless.

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(Atlas).

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3. Tethya lyncurium. *4. Euspongia officinalis.*
5. Axinella.

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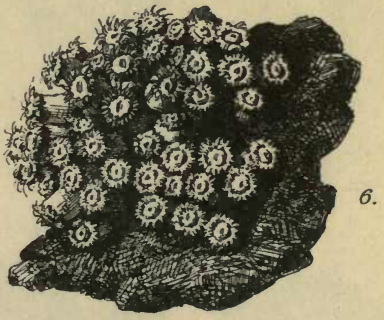

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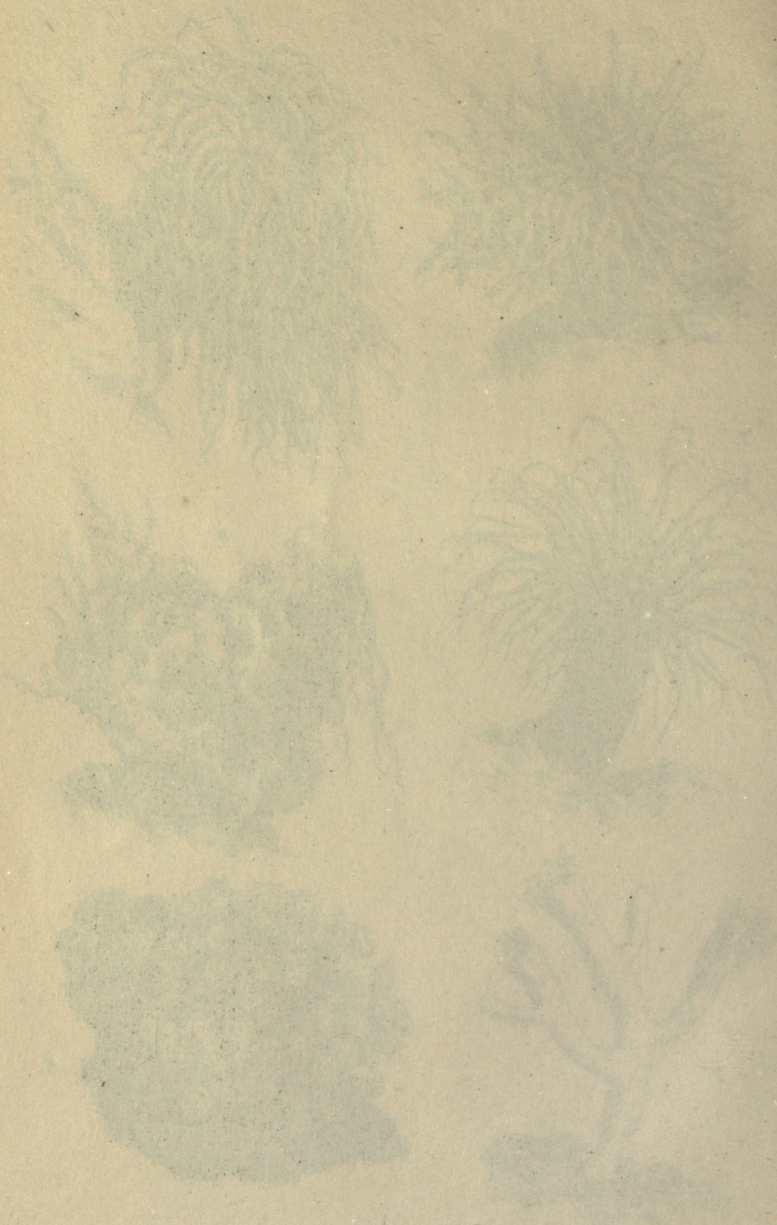

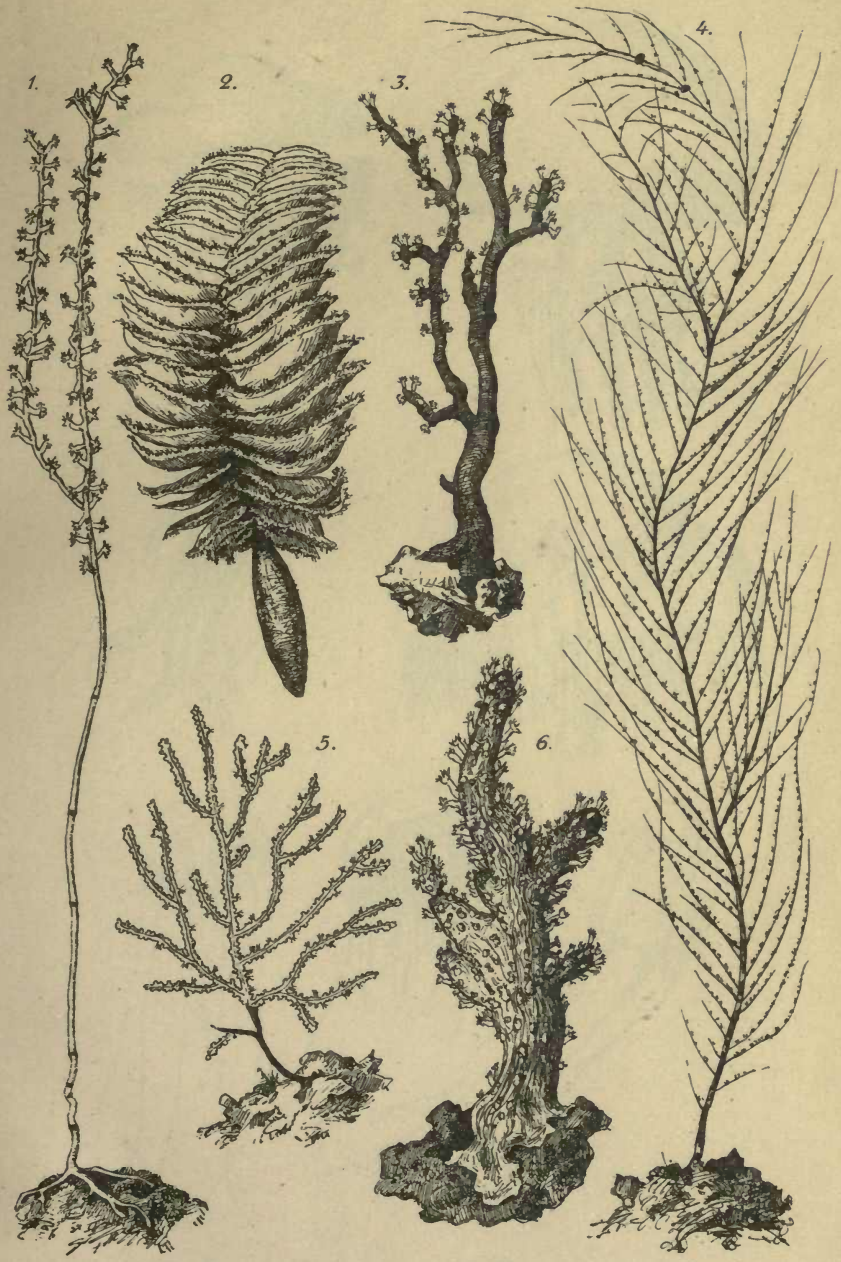

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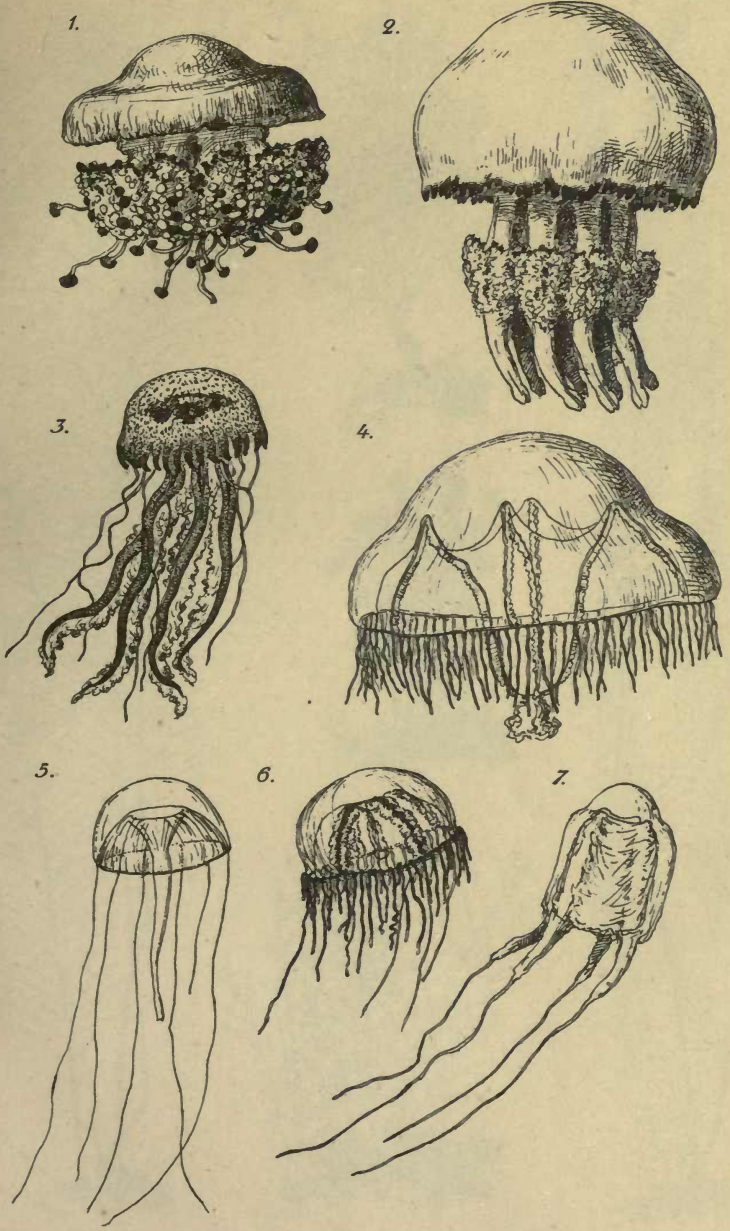

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3. *Pelagia noctiluca.*
4. *Tima flavilabris.*
5. *Carmarina hastata.*
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7. *Charybdaea marsupialis.*

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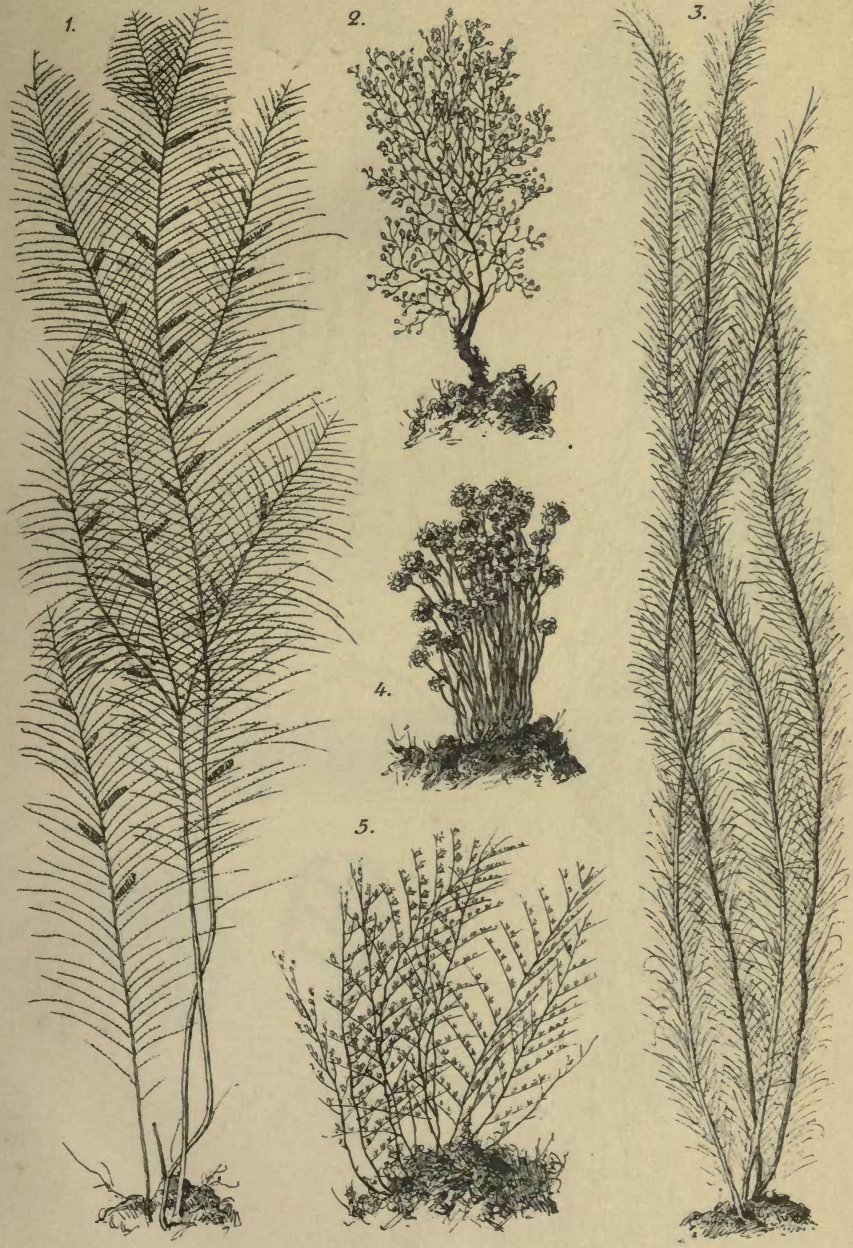

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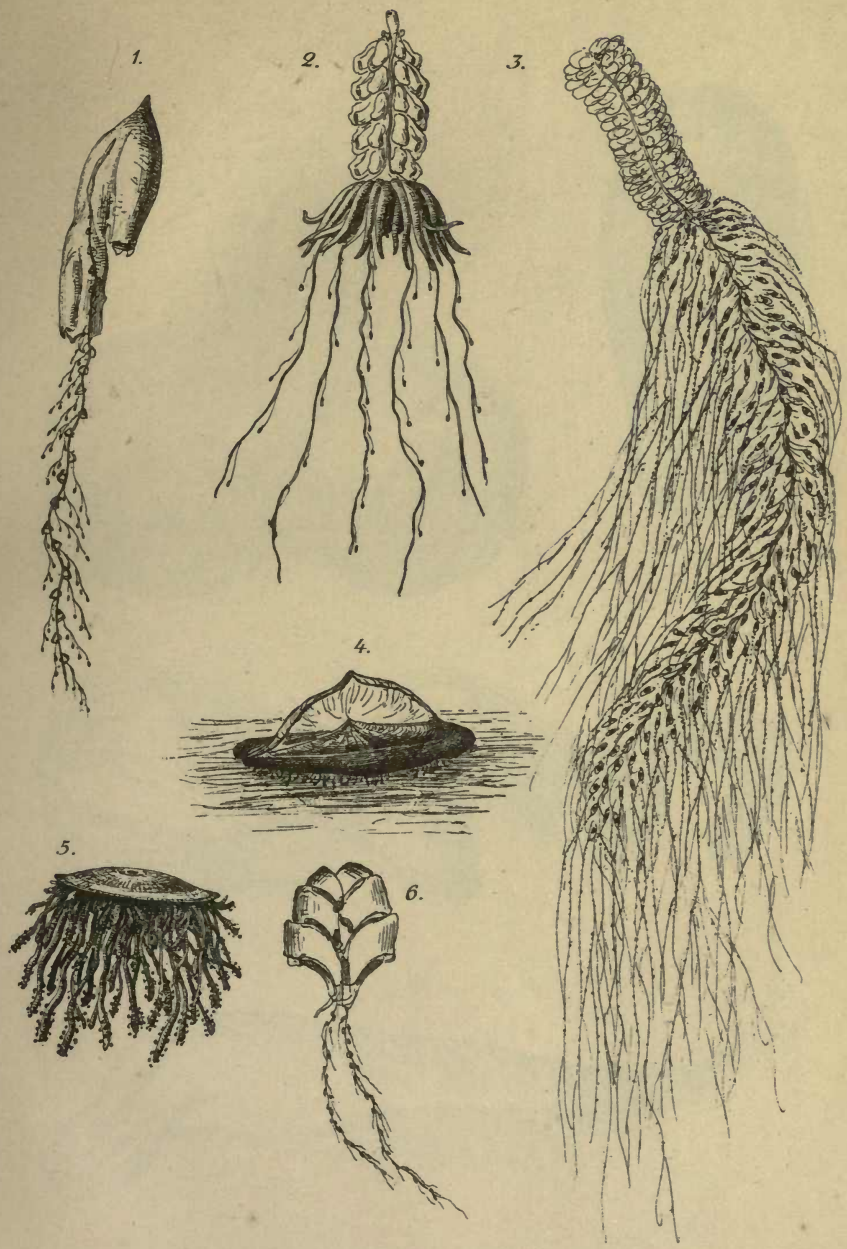

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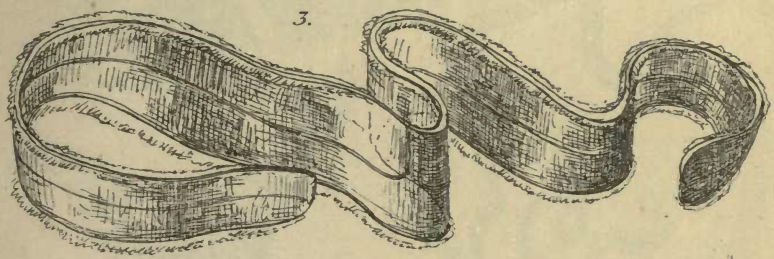
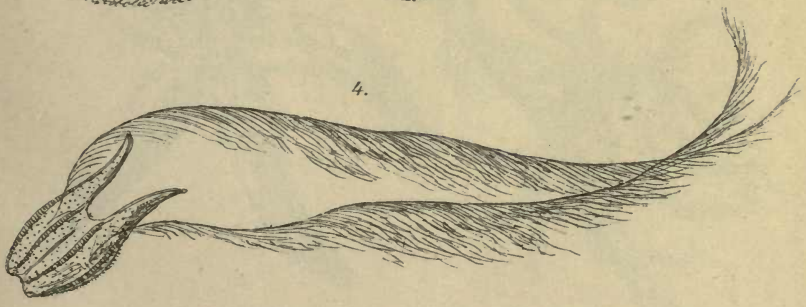
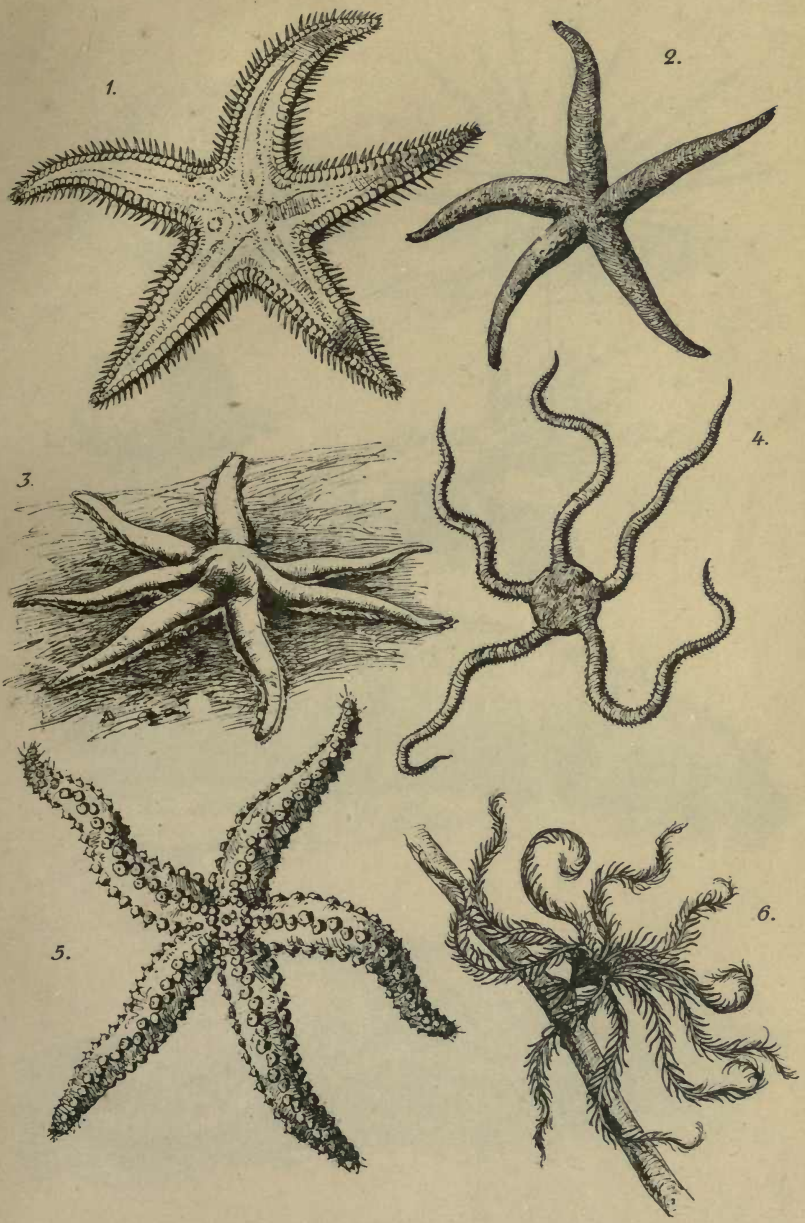




1. Eucharis multicornis. *2. Beroë ovata.*
3. Cestus Veneris. *4. Callianira bialata.*

C. Merculiano fec. Werner & Winter, impr.



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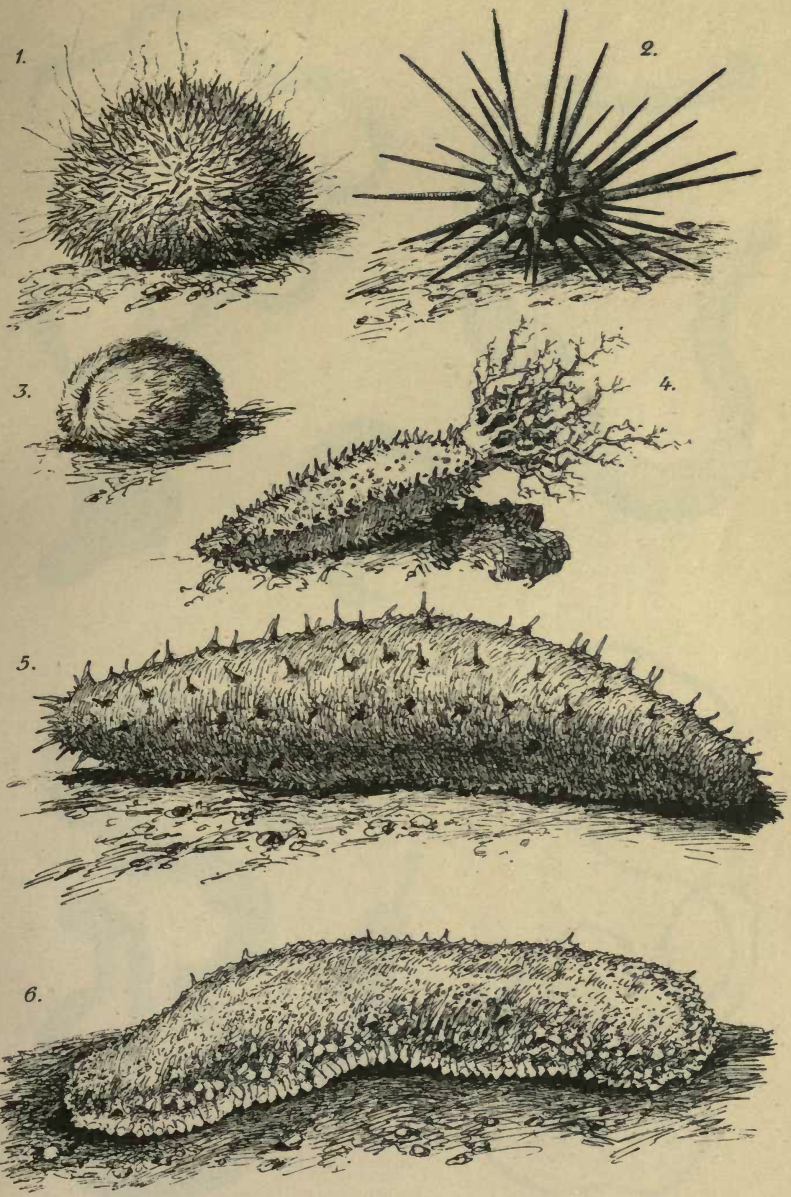

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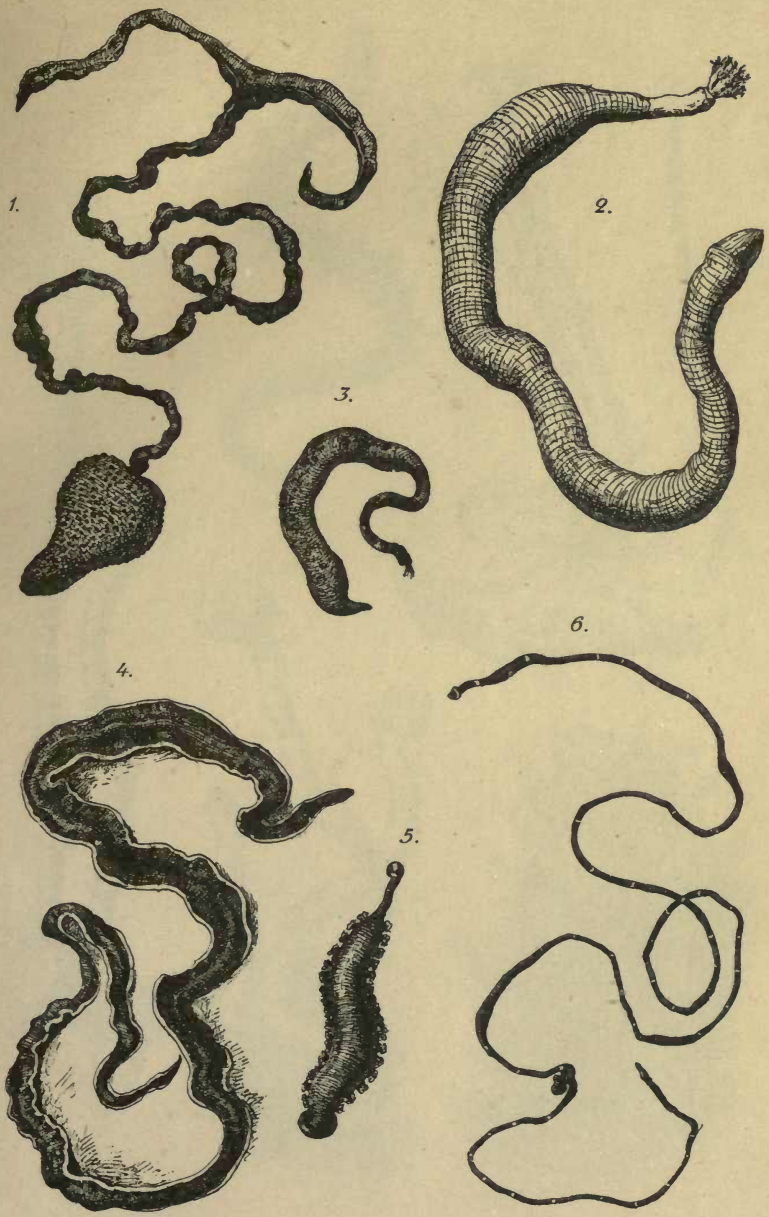

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6. *Carinella annulata.*

C. Merculiano fec.

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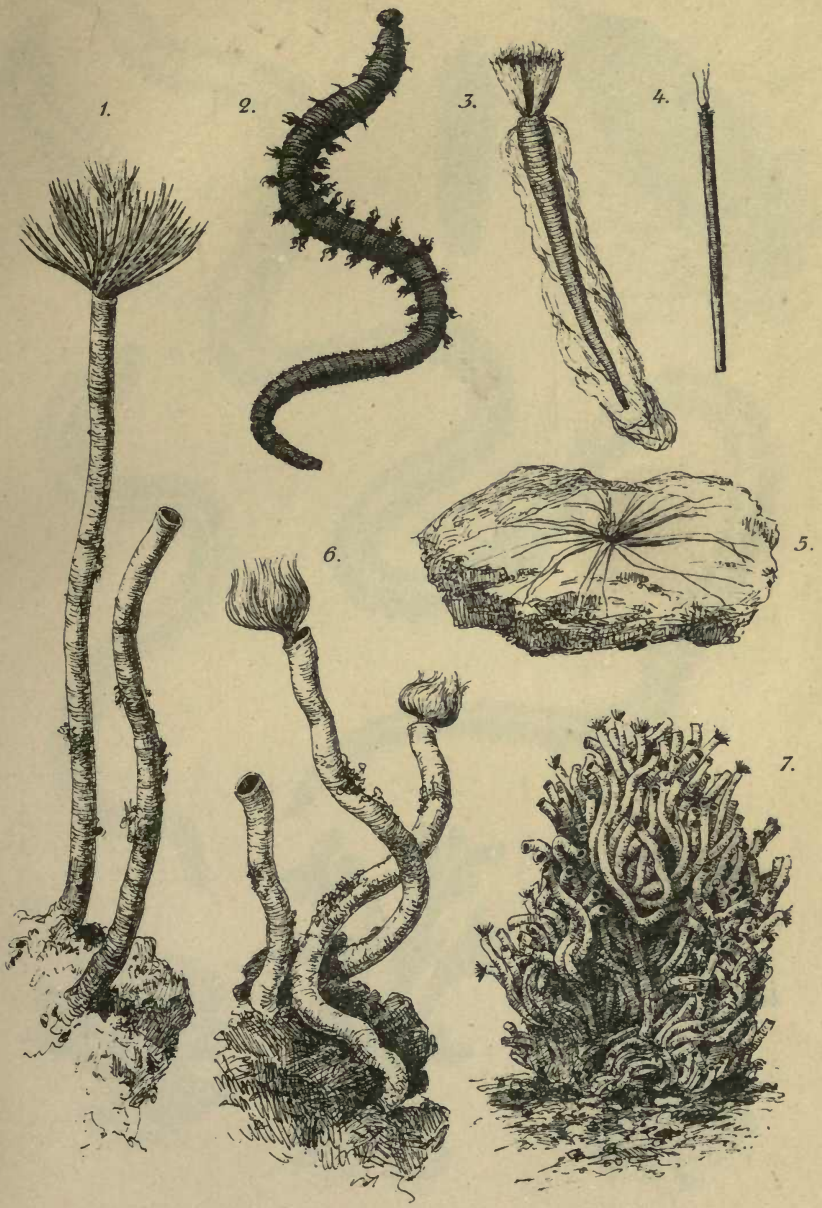

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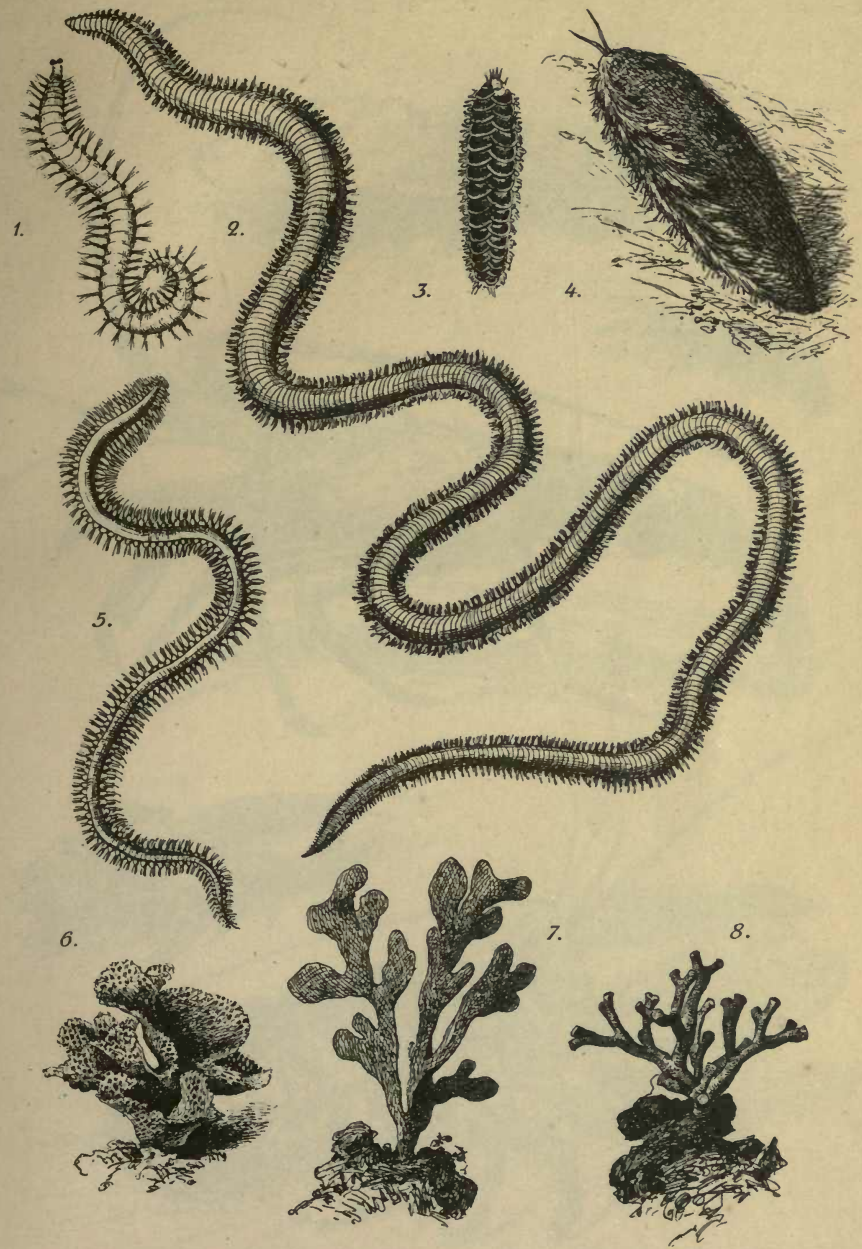

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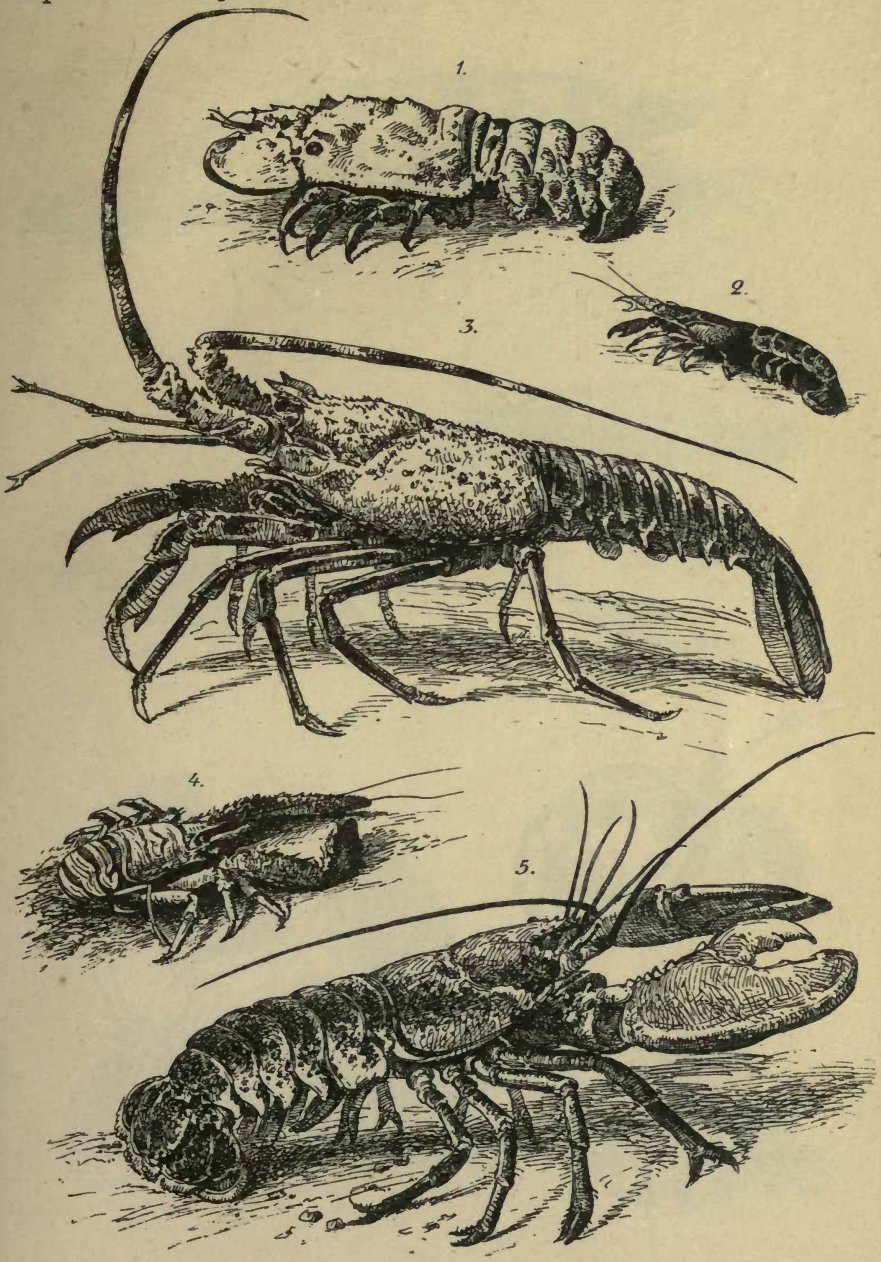

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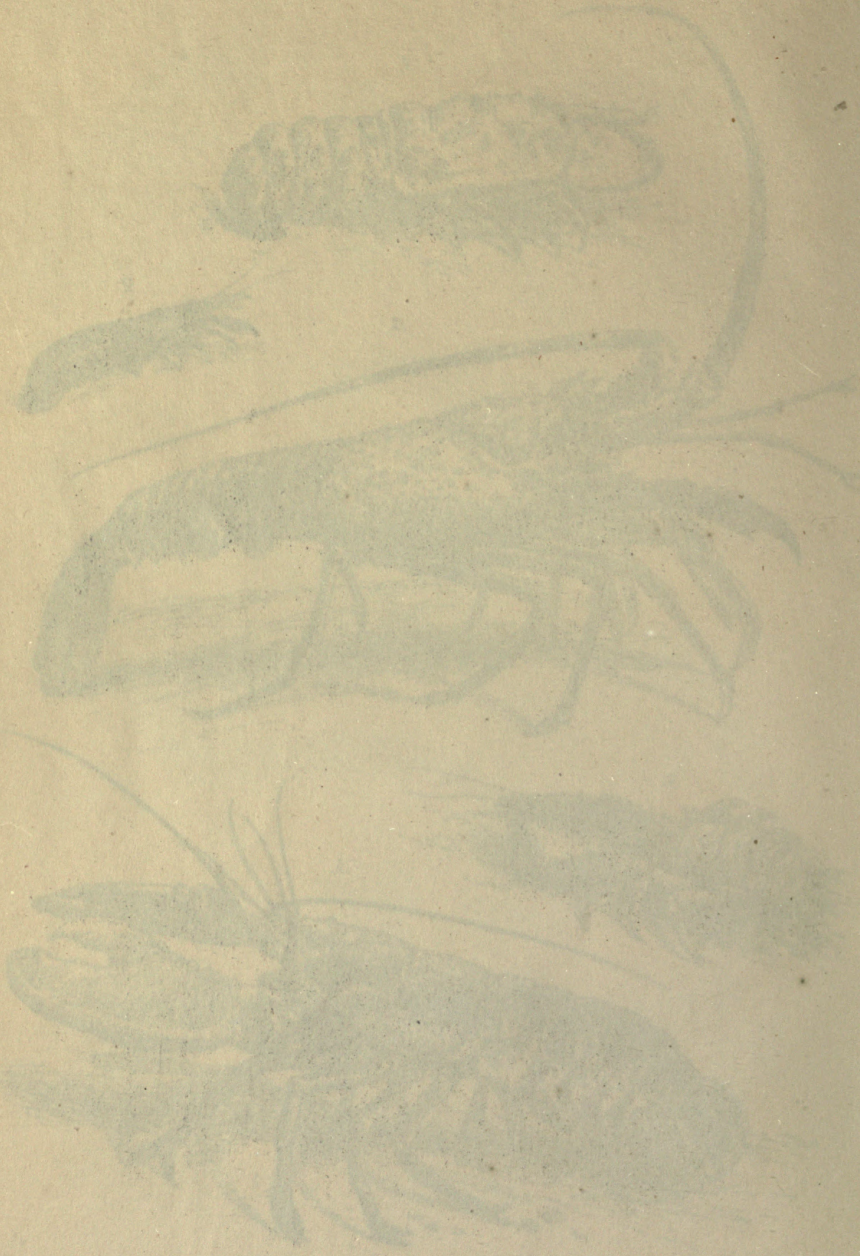

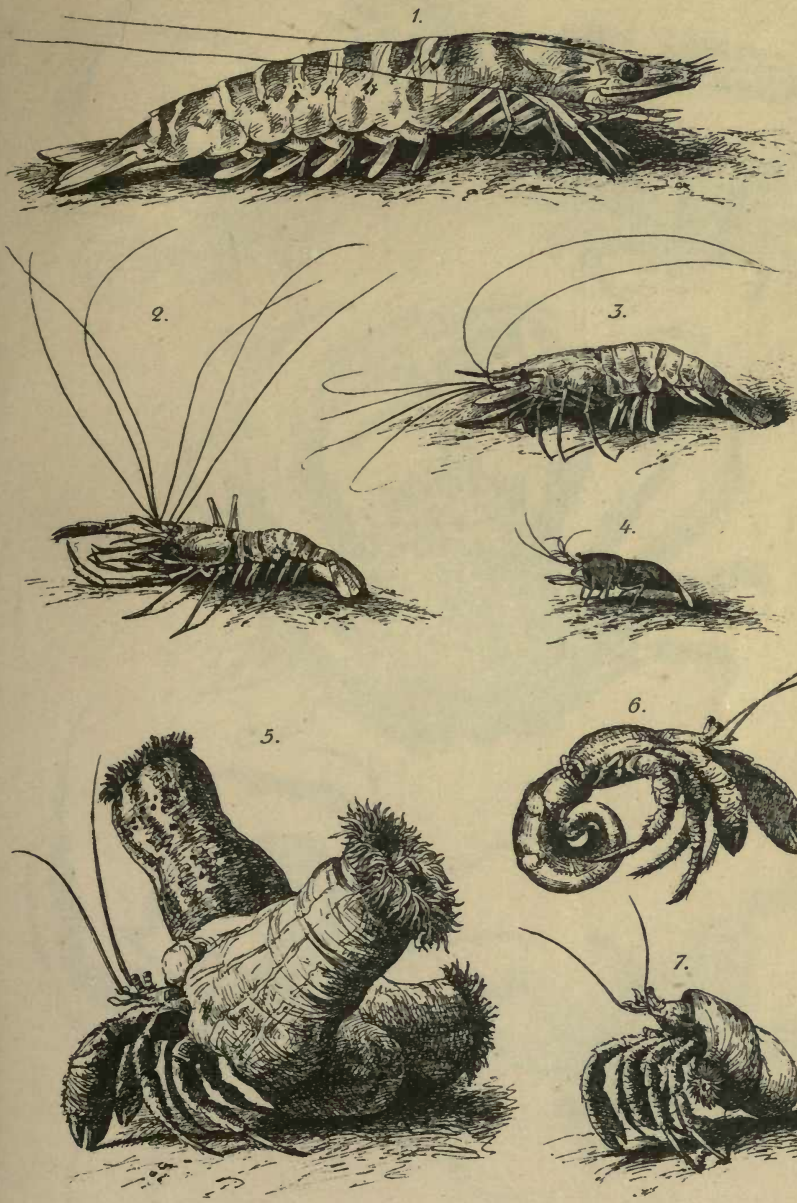

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5. *Pagurus striatus (et Adamsia Rondeletii.)*
6. *Pagurus striatus.*
7. *Eupagurus Prideauxii (et Adamsia palliata.)*

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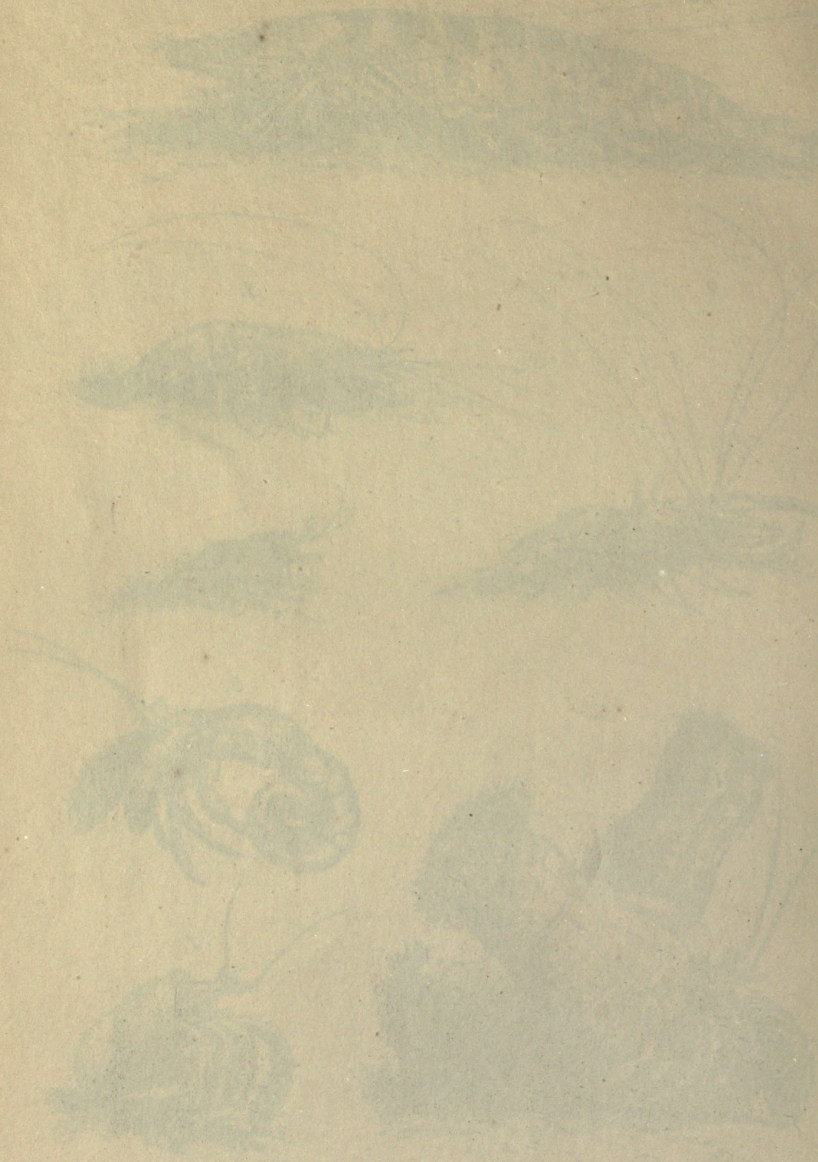

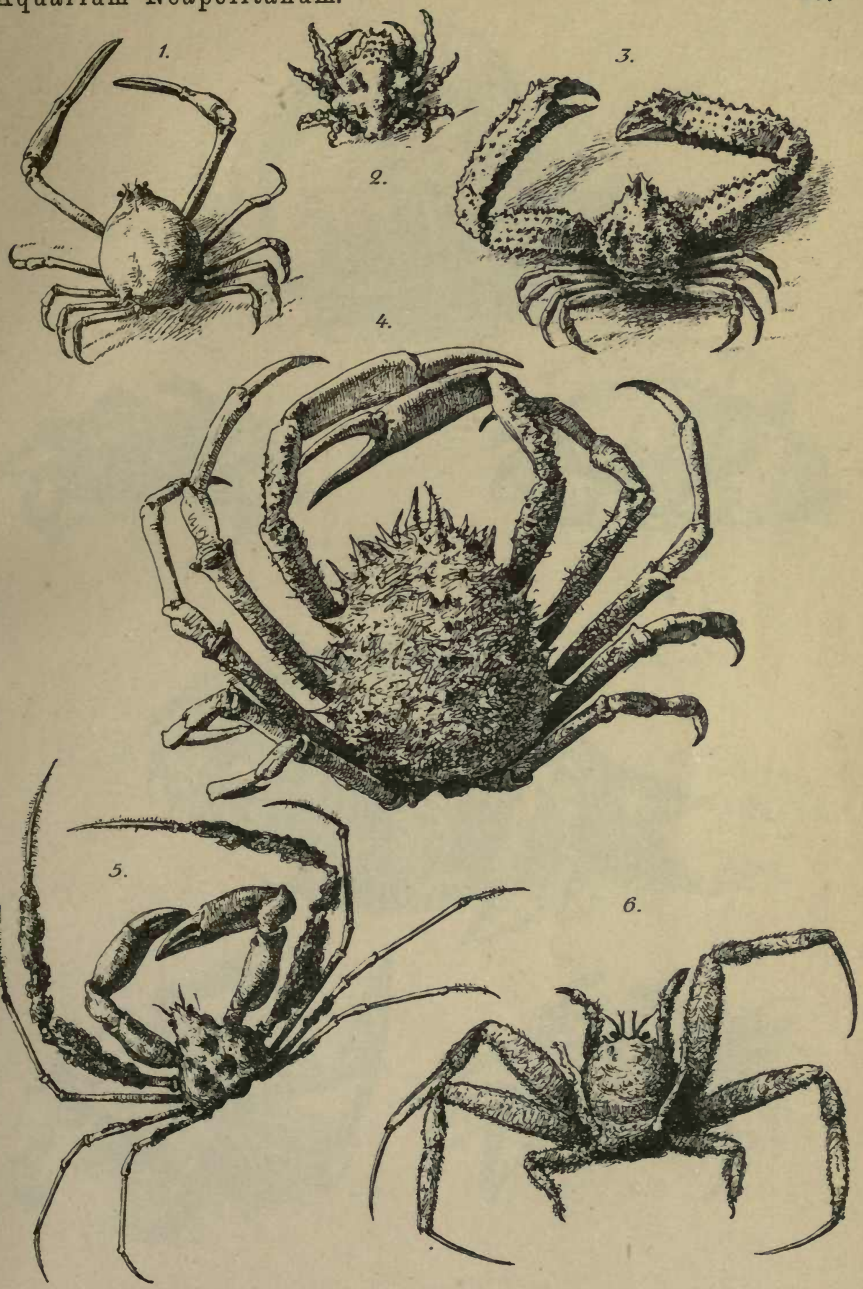

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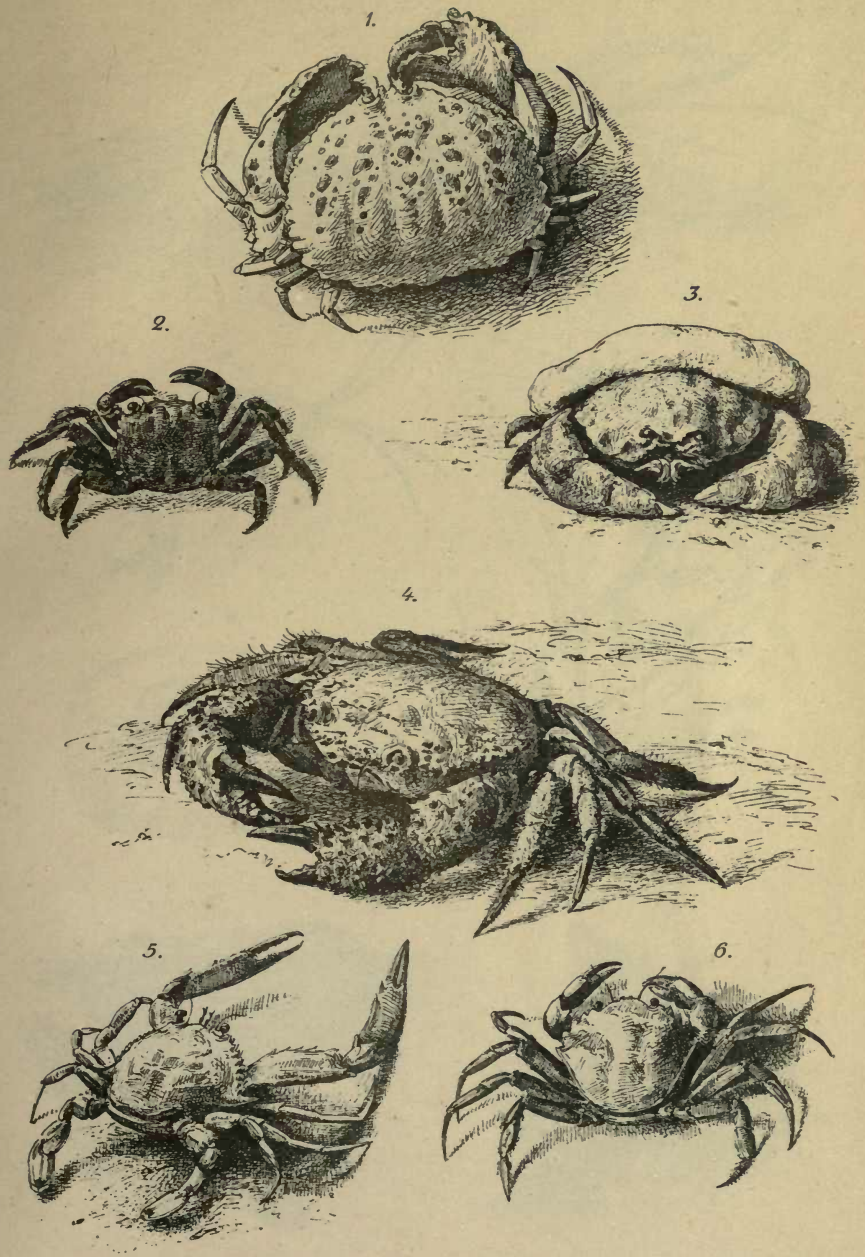

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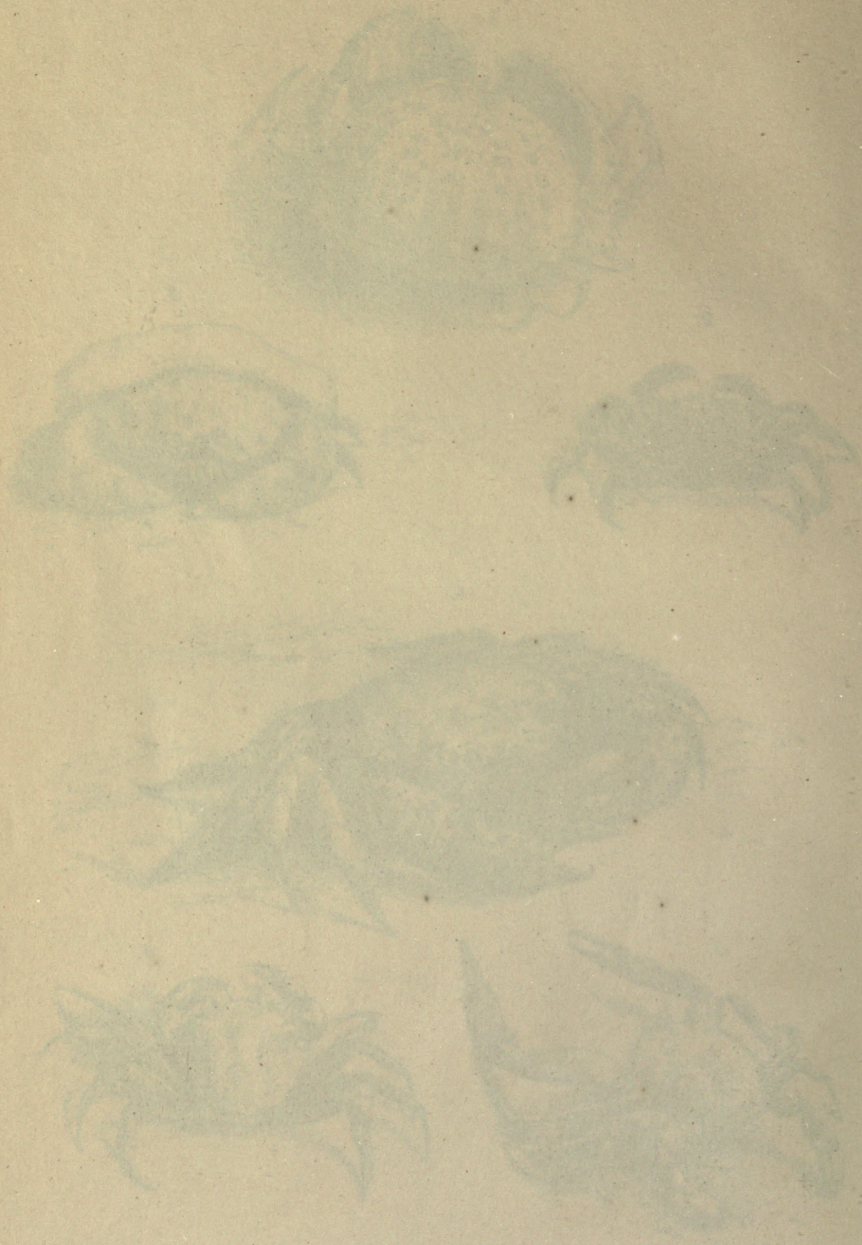

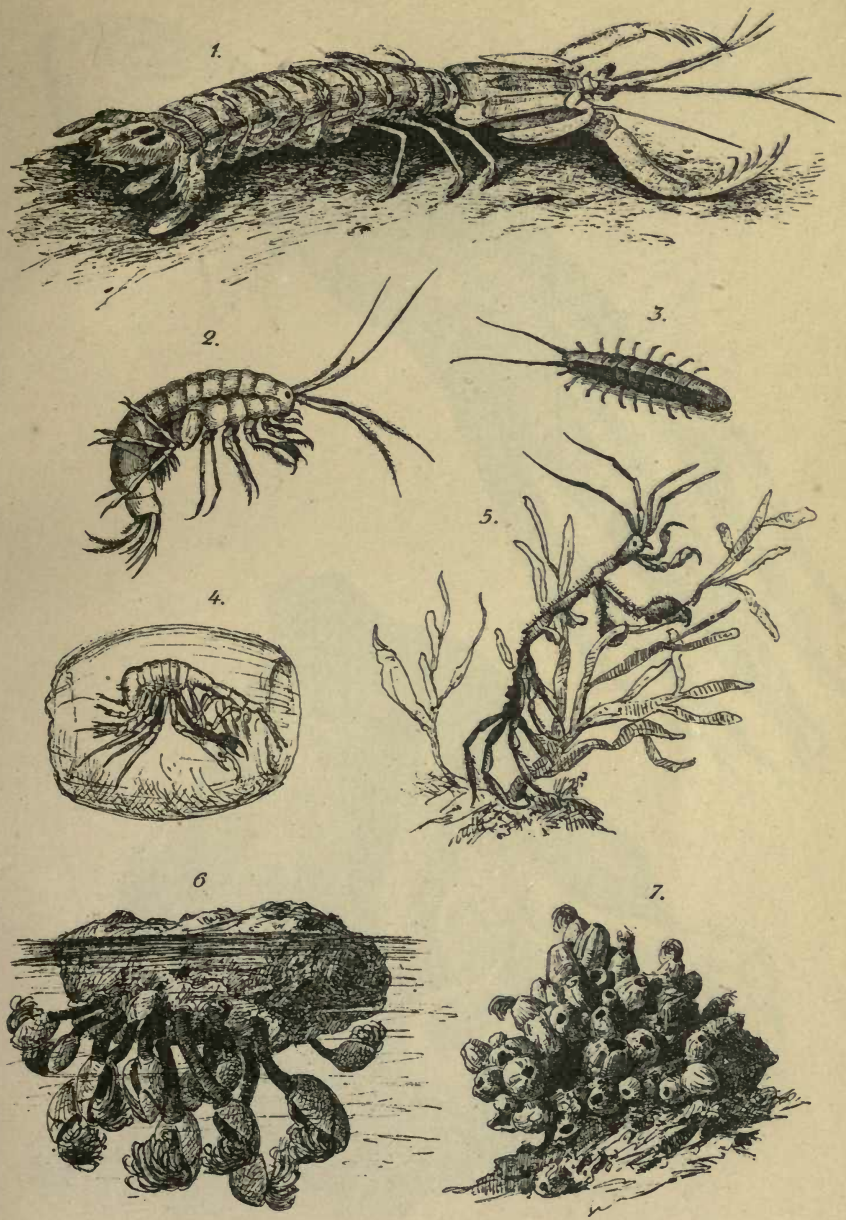

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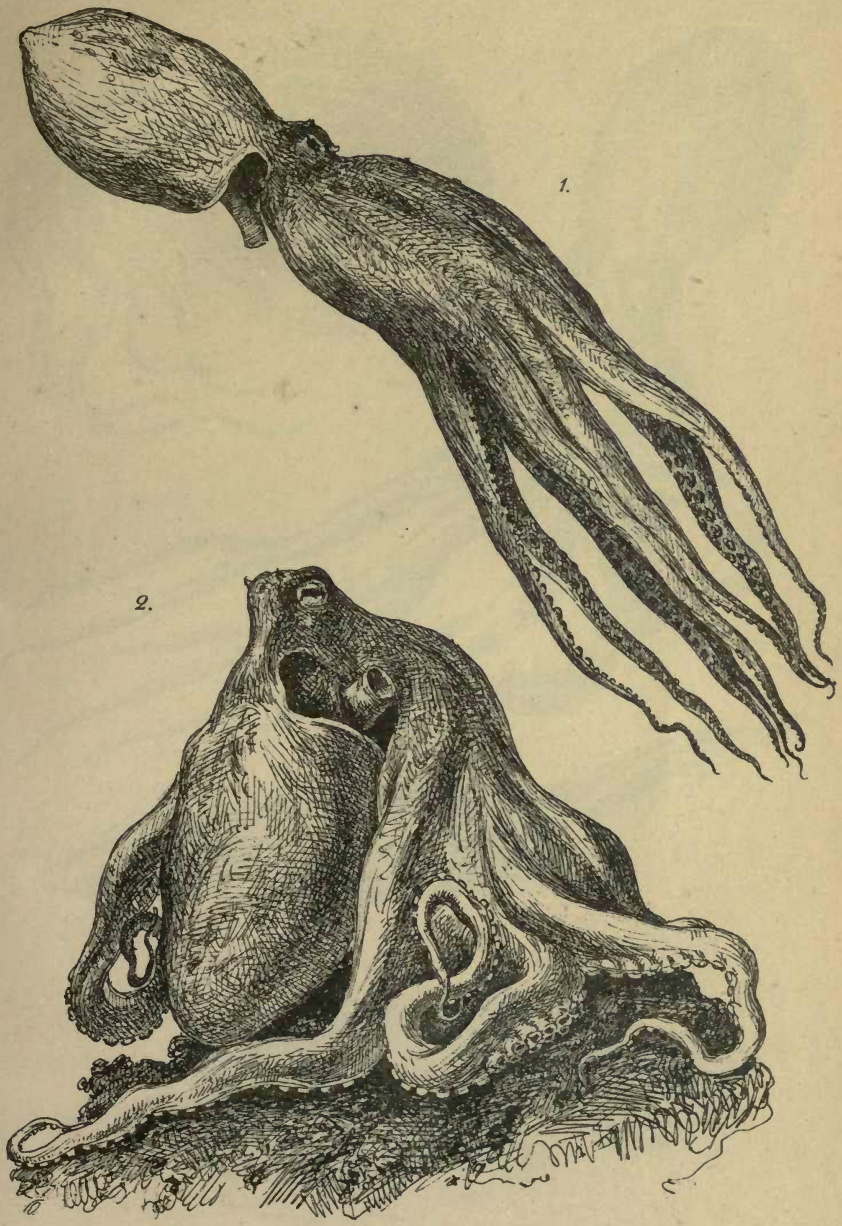
C. Merculiano fec.

Werner & Winter, impr.



1. 2. Octopus vulgaris.

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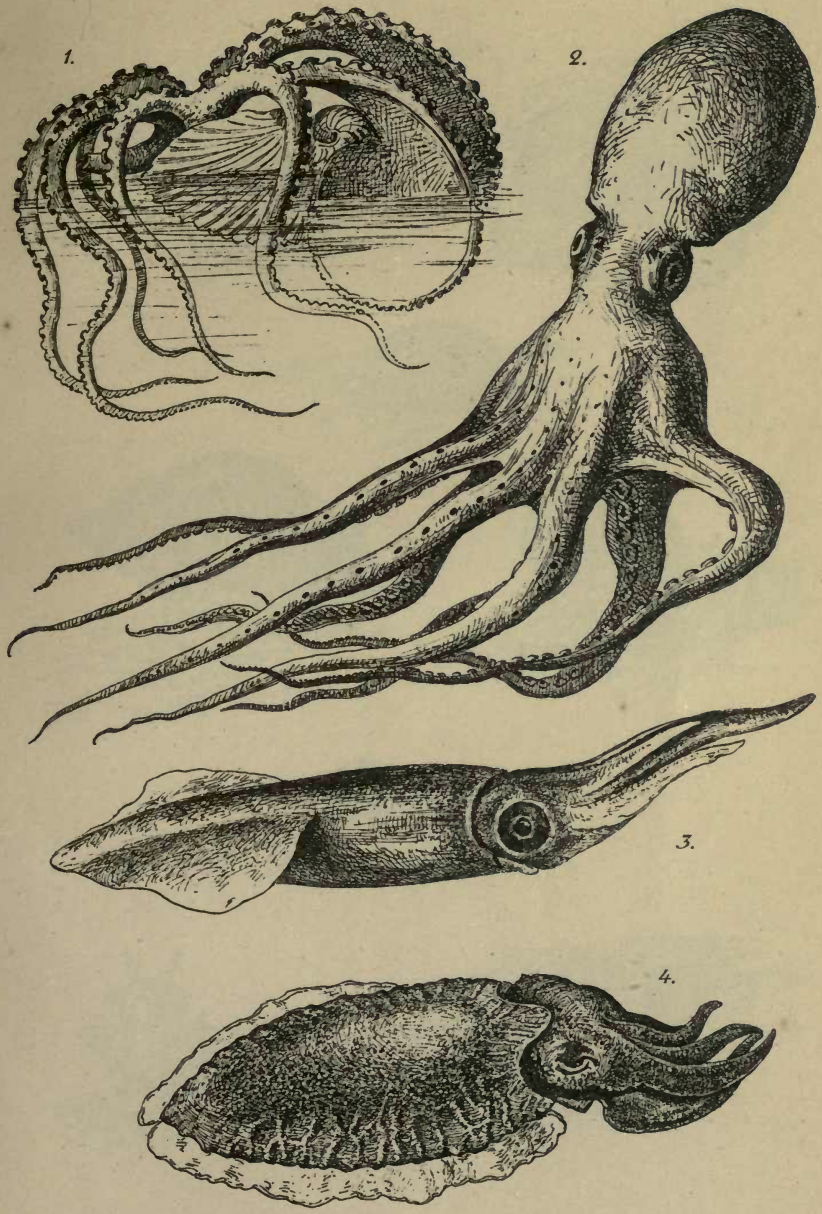
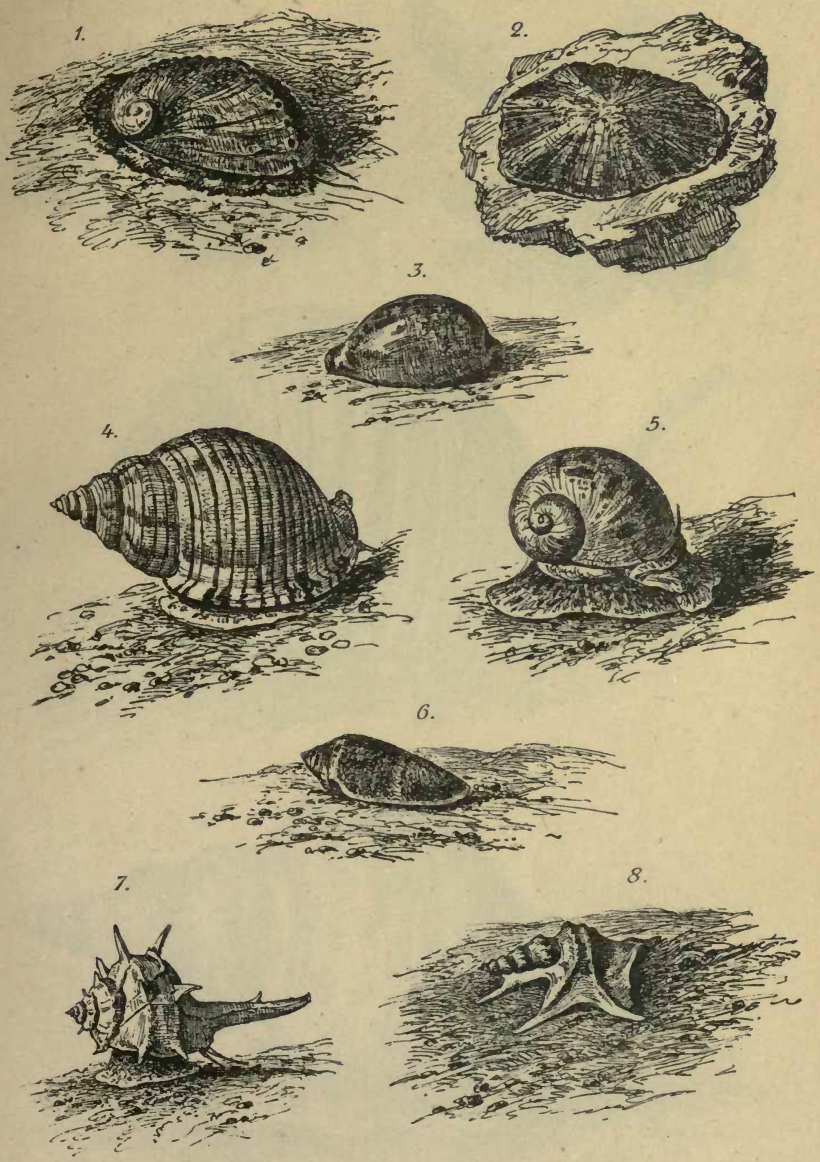


1. Argonauta argo. *2. Eledone moschata.*
3. Loligo vulgaris. *4. Sepia officinalis.*

C. Merculiano fec. Werner & Winter, impr.



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5. *Natica millepunctata.*
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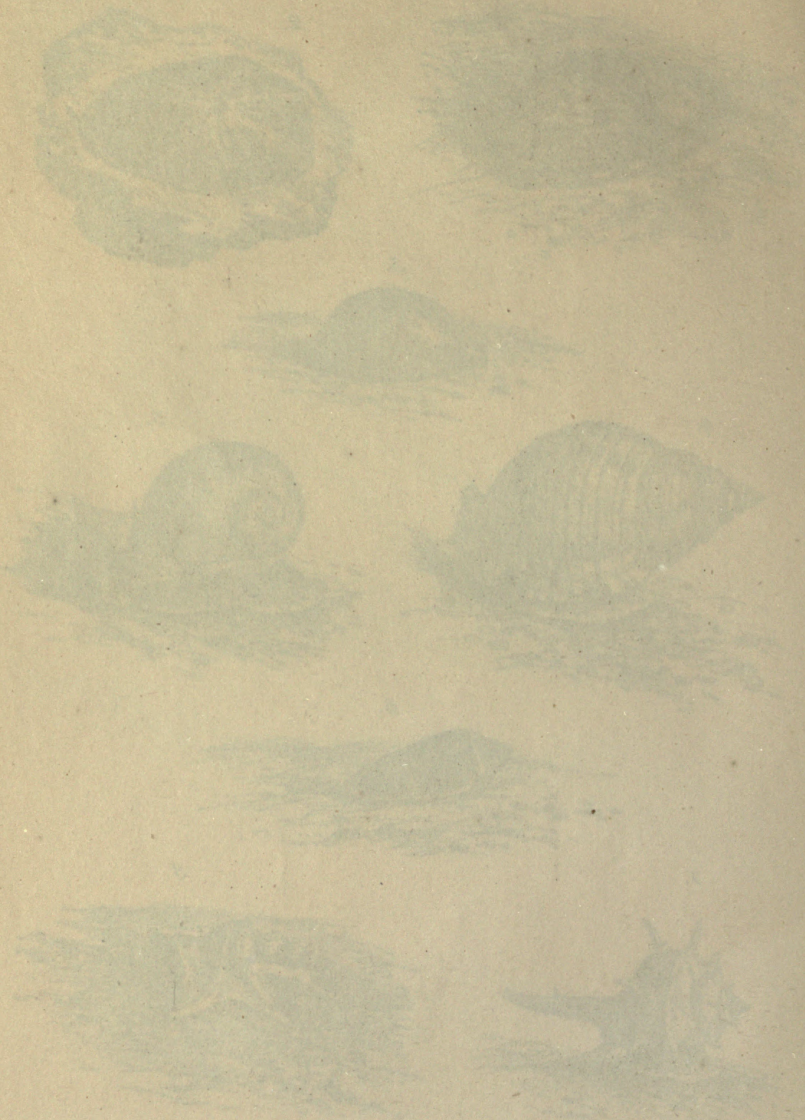
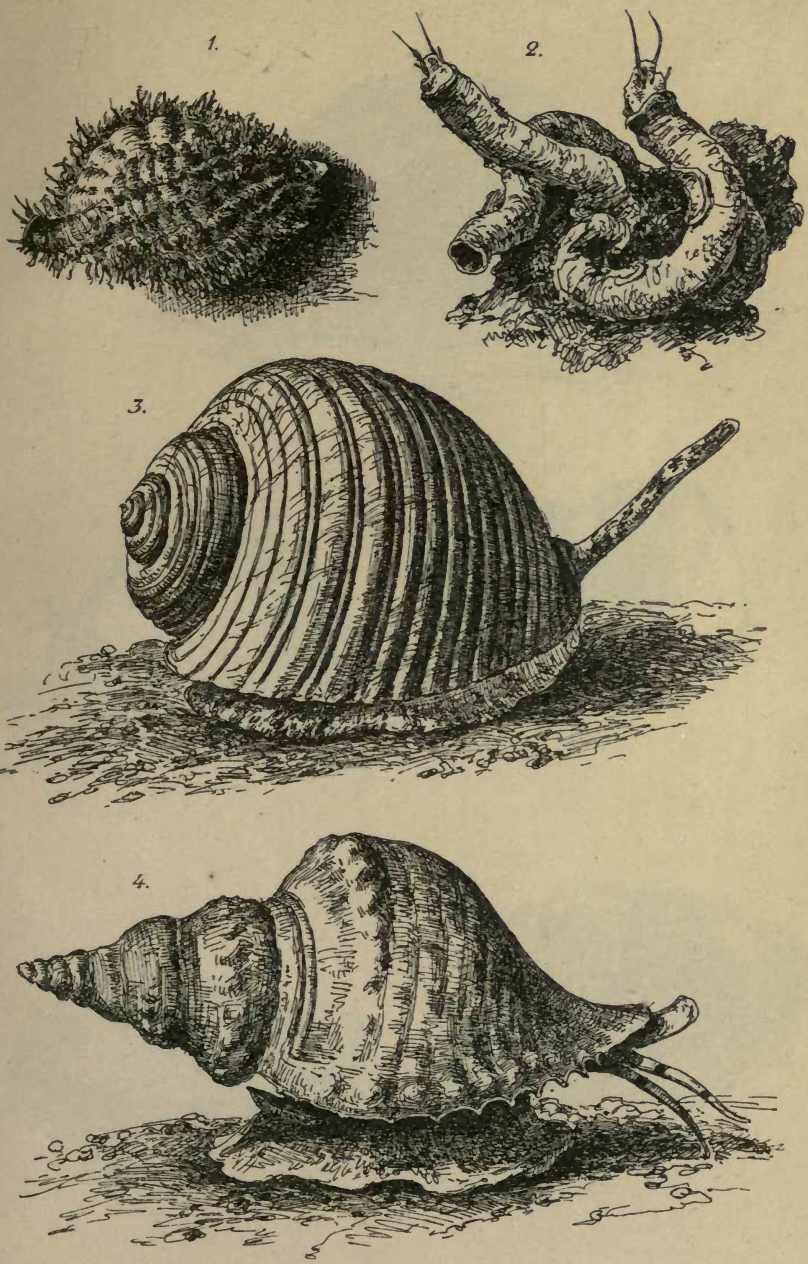
7. *Murex brandaris.*
8. *Aporrhais pes pelecani.*

C. Merculiano fec. Werner & Winter, impr.





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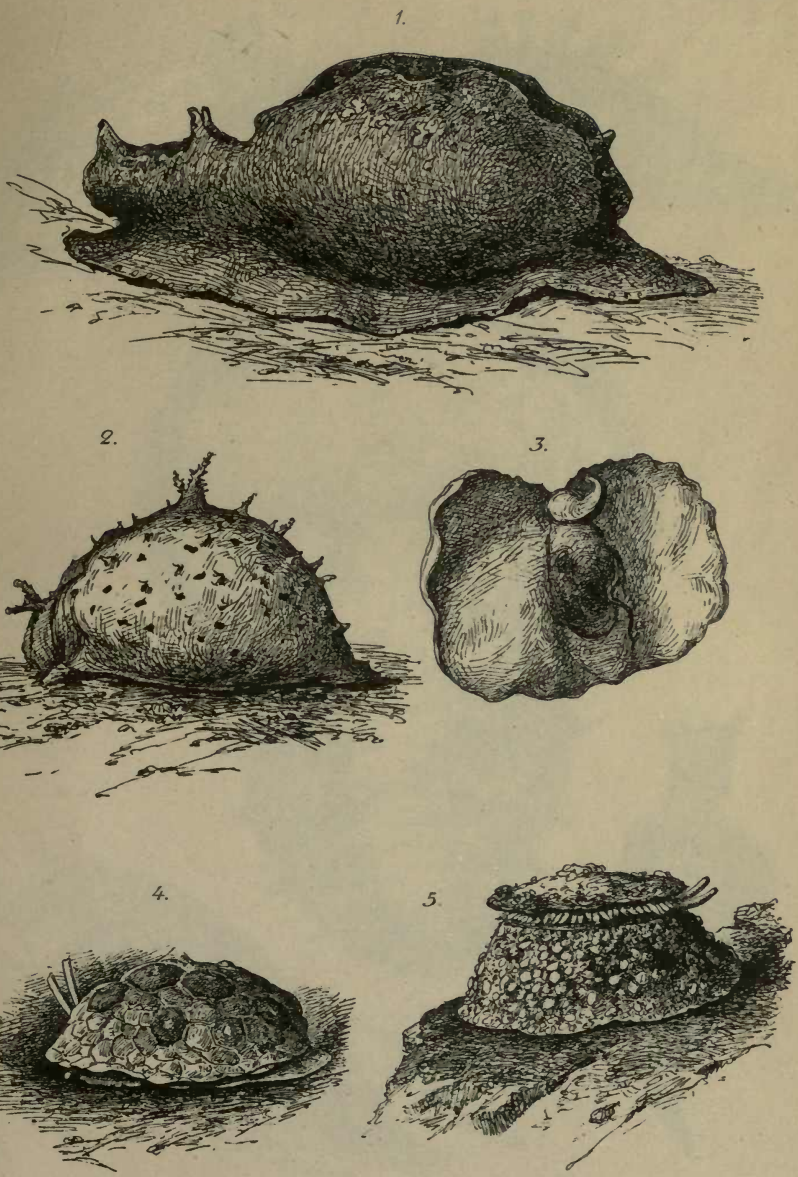
C. Merculiano fec. Werner & Winter, impr.



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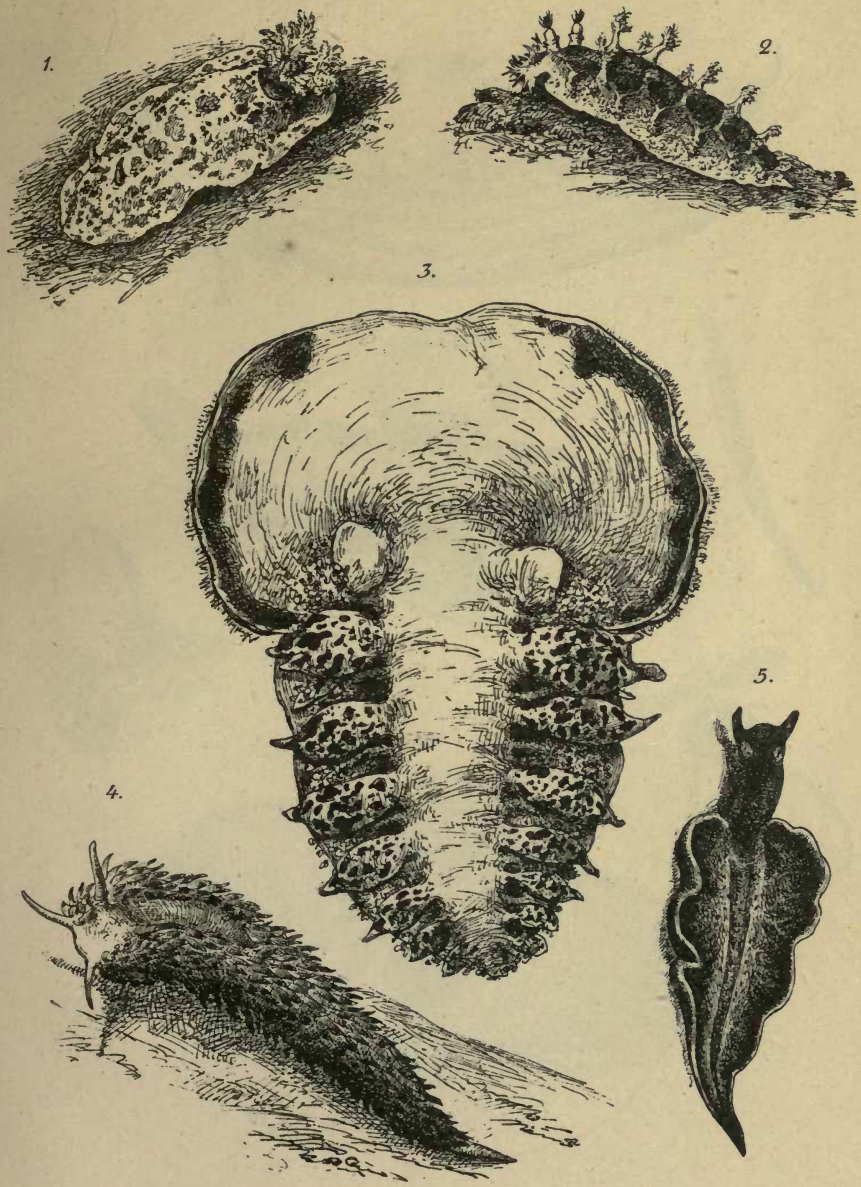
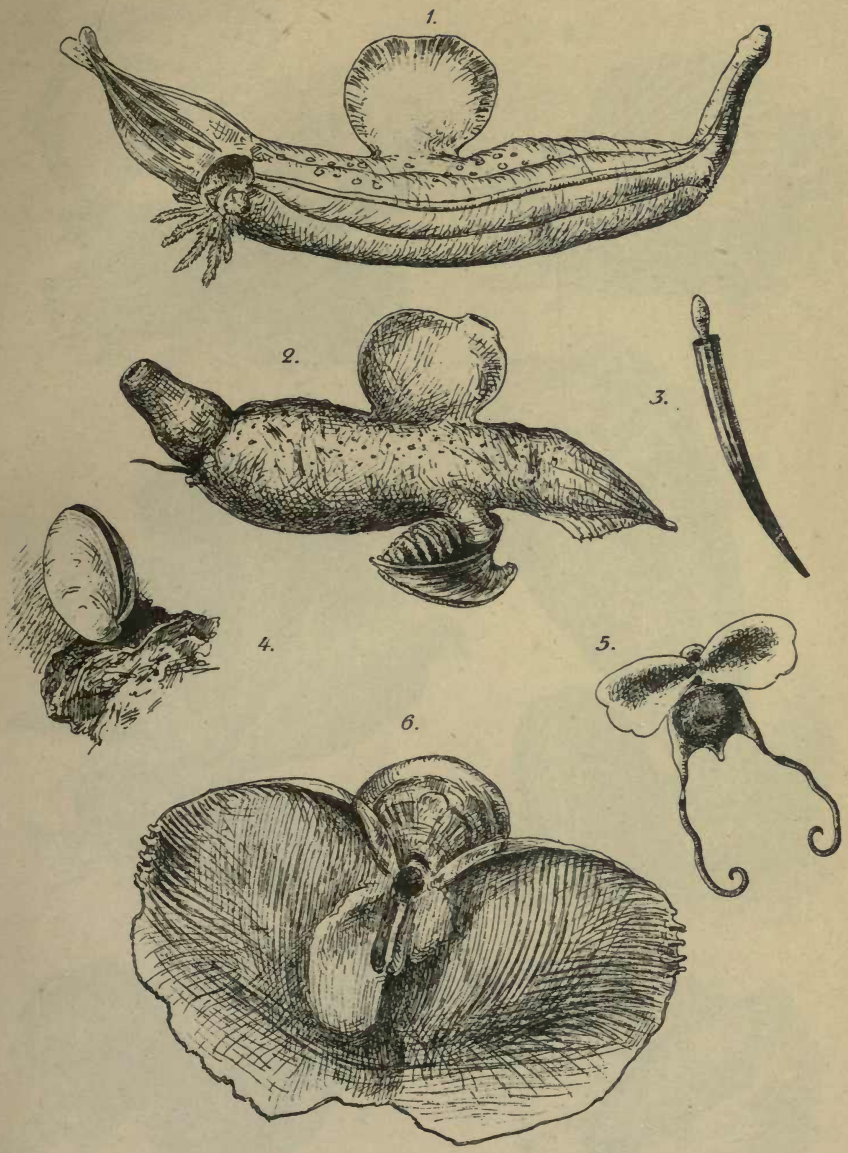
C. Merculiano fec. Werner & Winter, impr.



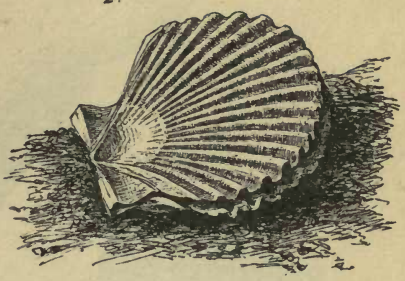
1. Doris tuberculata. *2. Marionia quadrilatera.*
3. Tethys leporina. *4. Aeolis papillosa.*
5. Elysia viridis.

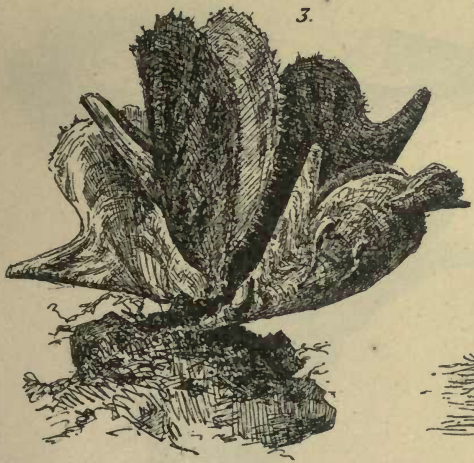
C. Merculiano fec. Werner & Winter, impr.

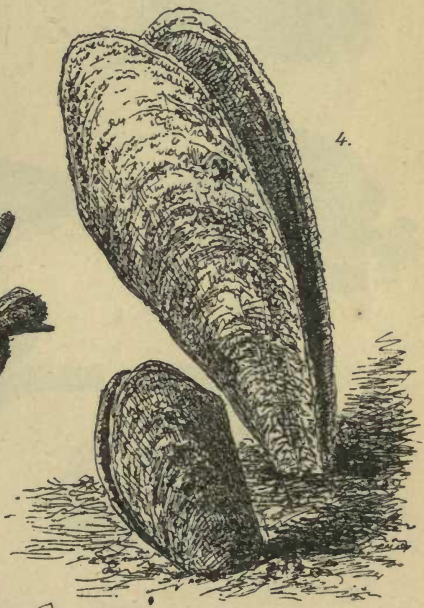


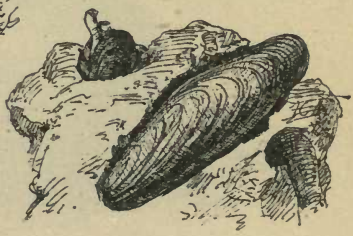
1. *Pterotrachea coronata.*
2. *Carinaria mediterranea.*
3. *Dentalium tarentinum.*
4. *Terebratula vitrea.*
5. *Hyalaea tridentata.*
6. *Tiedemannia neapolitana.*

C. Merculiano fec. Werner & Winter, impr.



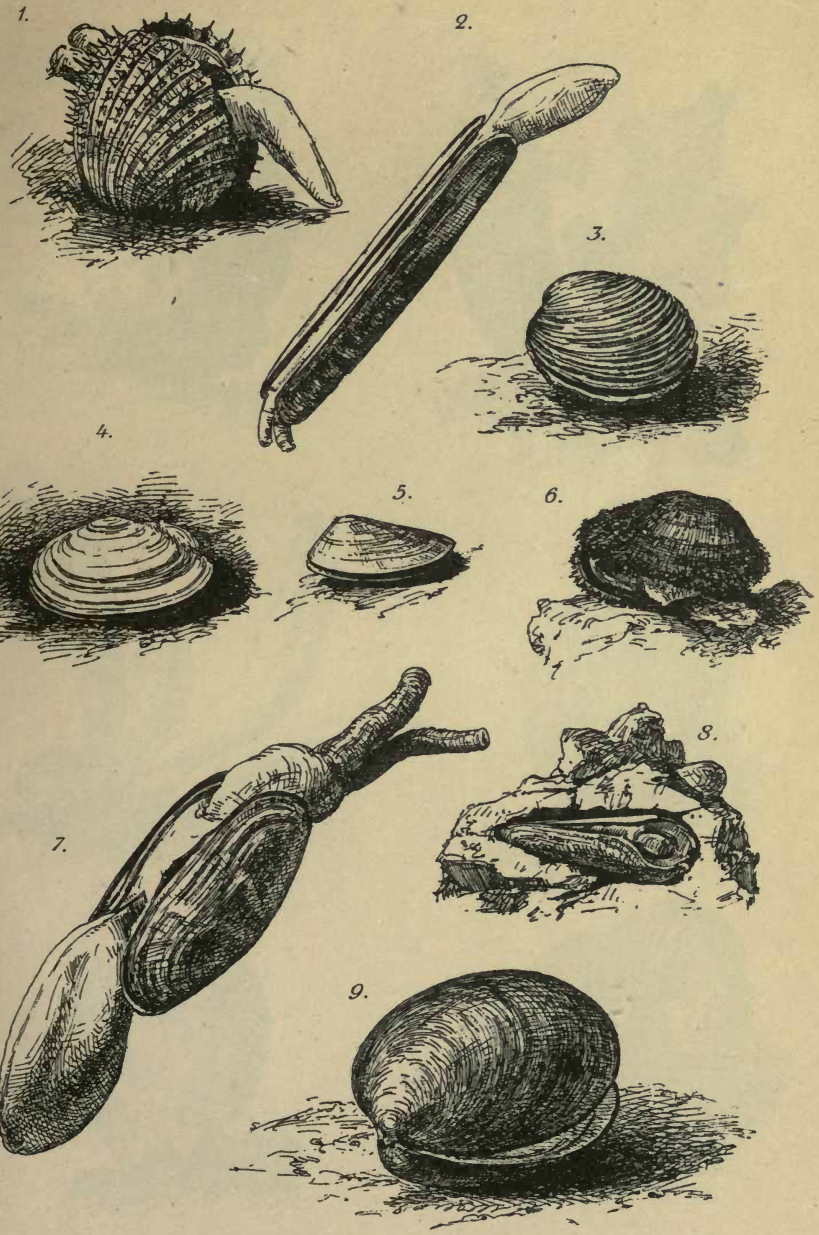






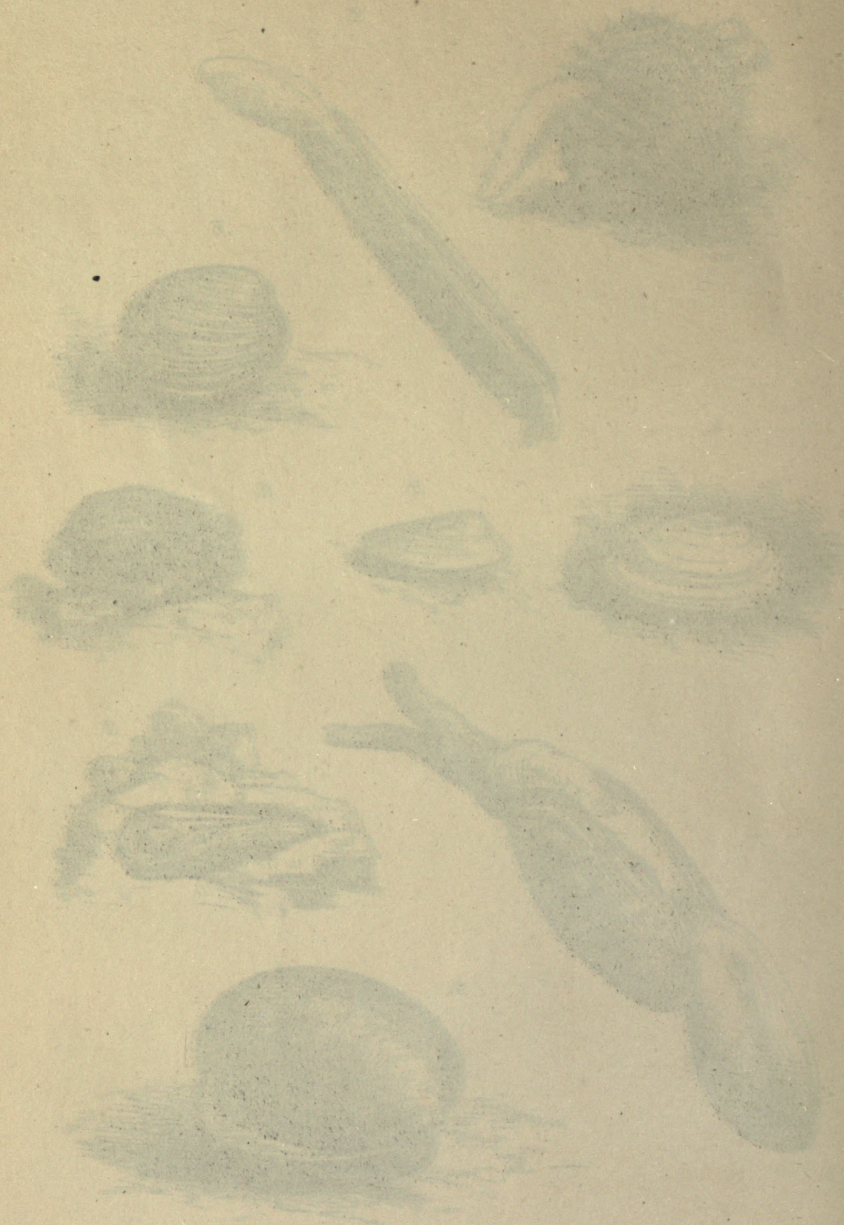
1. *Ostrea edulis.*
2. *Pecten jacobaeus.*
3. *Avicula hirundo.*
4. *Pinna nobilis.*
5. *Mytilus edulis.*
6. *Lithodomus dactylus.*

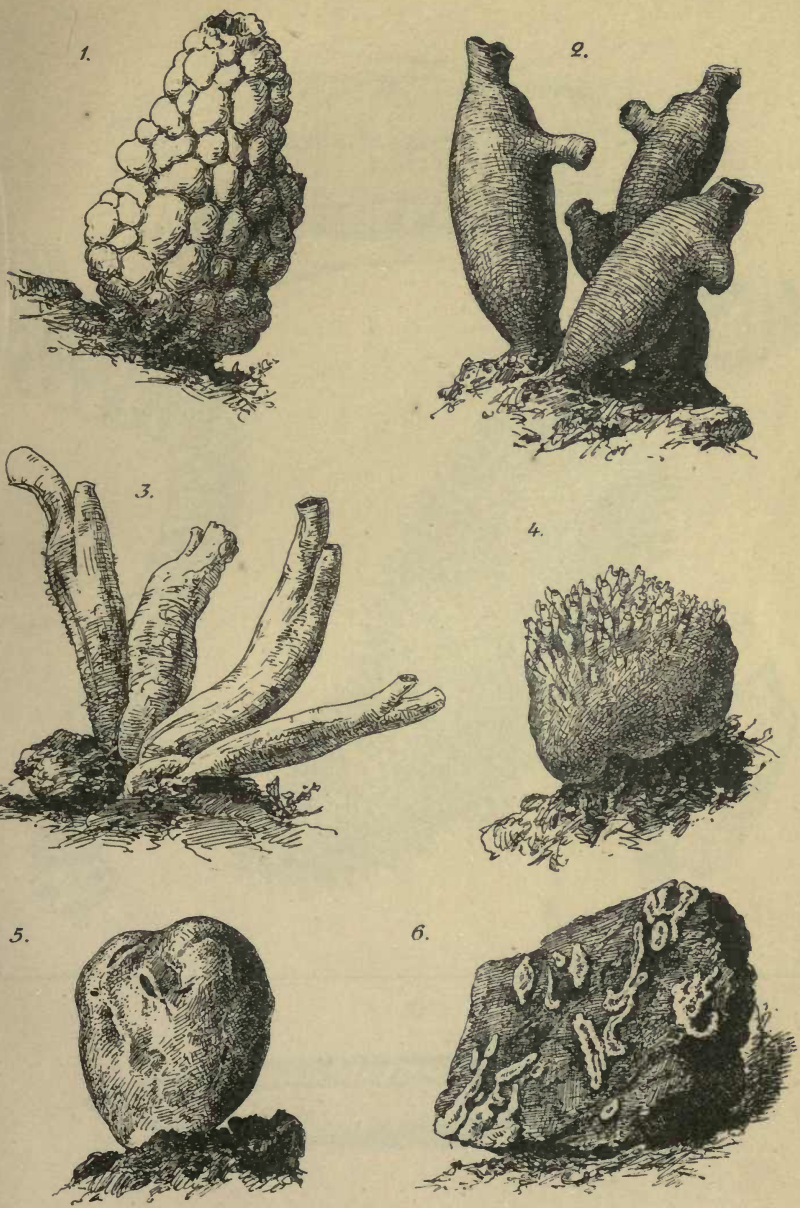
C. Merculiano fec. Werner & Winter, impr.



1. *Cardium aculeatum.*
2. *Solen vagina.*
3. *Venus verrucosa.*
4. *Tellina planata.*
5. *Donax trunculus.*
6. *Arca barbata.*
7. *Solecurtus strigilatus.*
8. *Pholas dactylus.*
9. *Pectunculus glycimeris.*

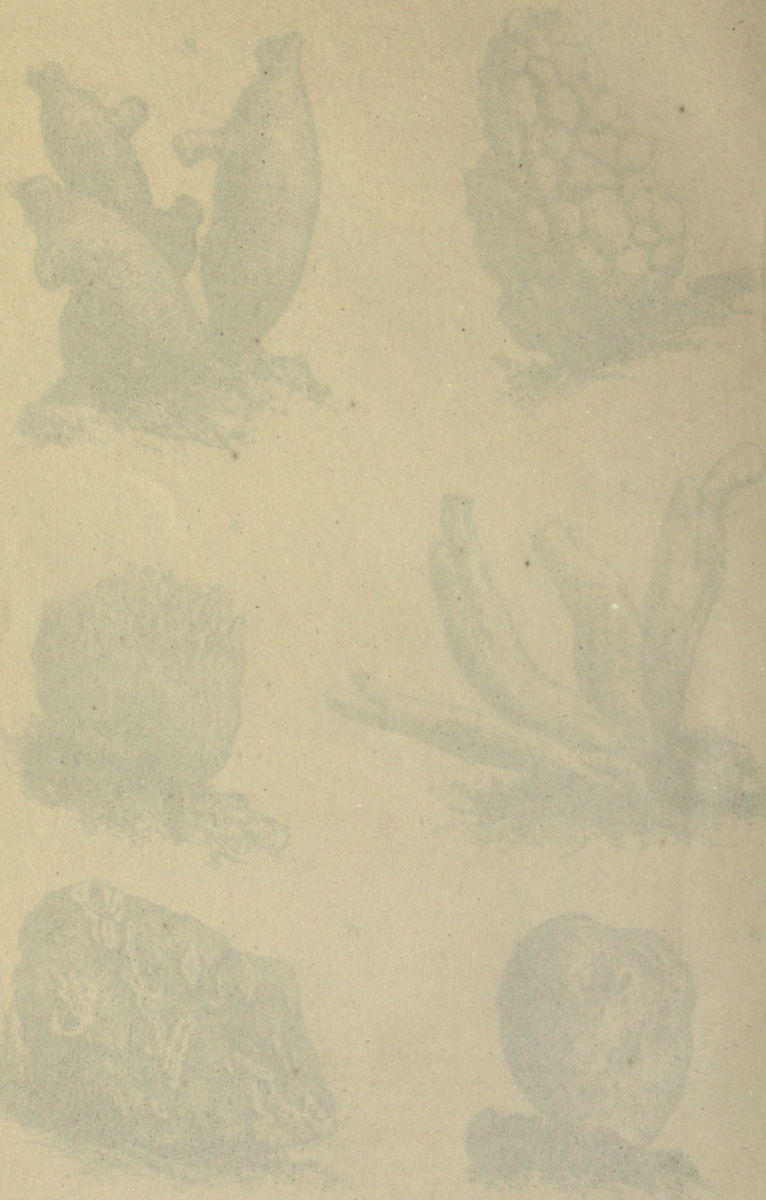
C. Merculiano fec. Werner & Winter, impr.

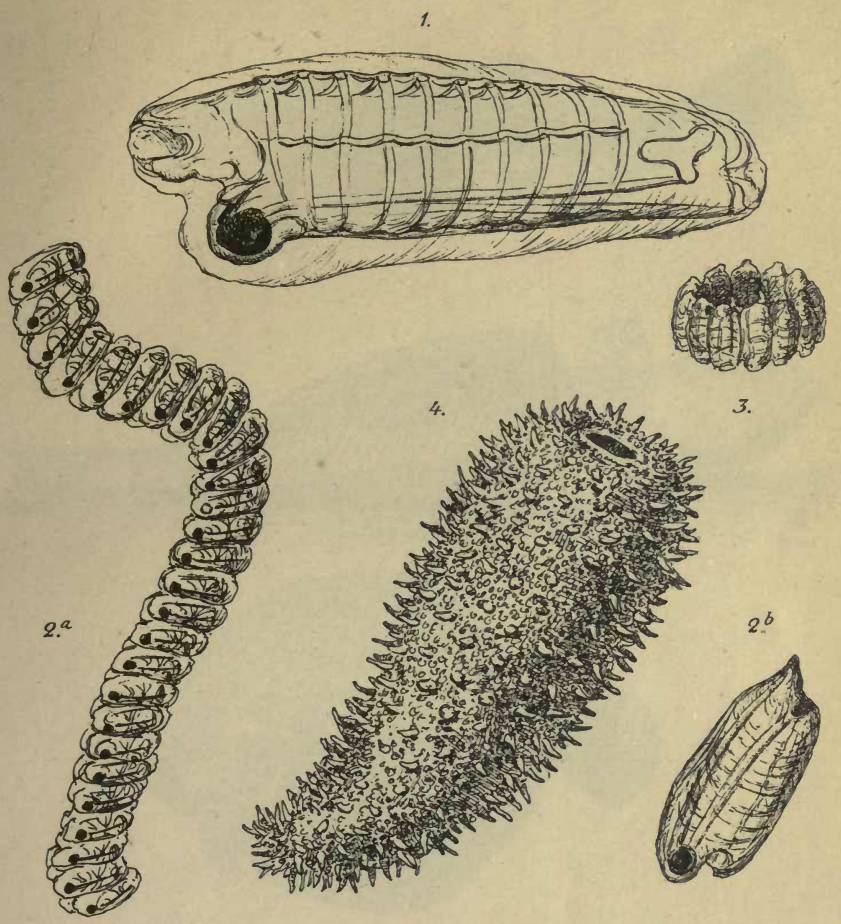


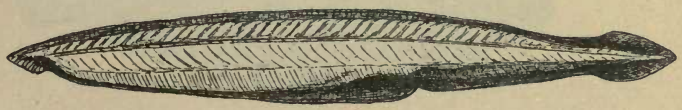


1. *Phallusia mammillata.*
2. *Cynthia papillosa.*
3. *Ciona intestinalis.*
4. *Diazona violacea.*
5. *Fragarium areolatum.*
6. *Botryllus aurolineatus.*

C. Merculiano fec. Werner & Winter, impr.





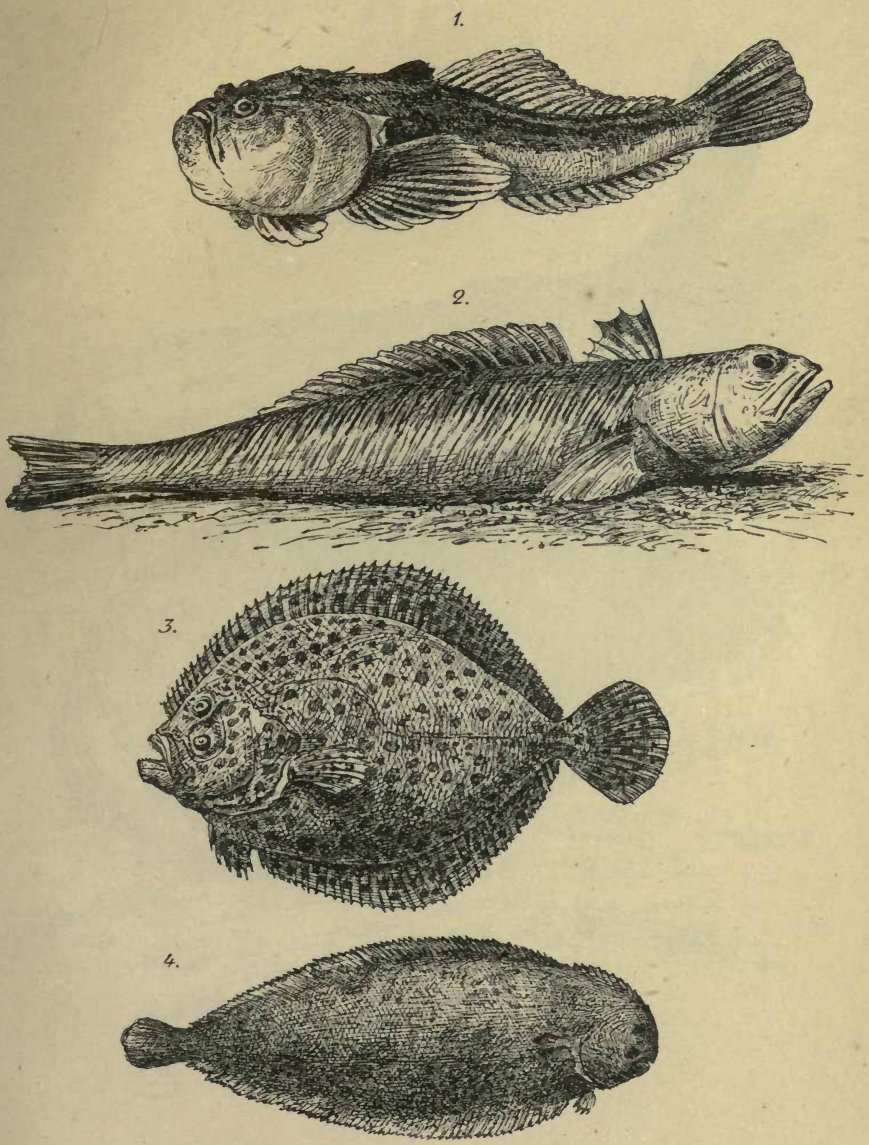


1. Salpa maxima-africana (solitaria). *2a. et 2b. Salpa maxima-africana (gregata).*

3. Salpa pinnata (gregata). *4. Pyrosoma elegans.*

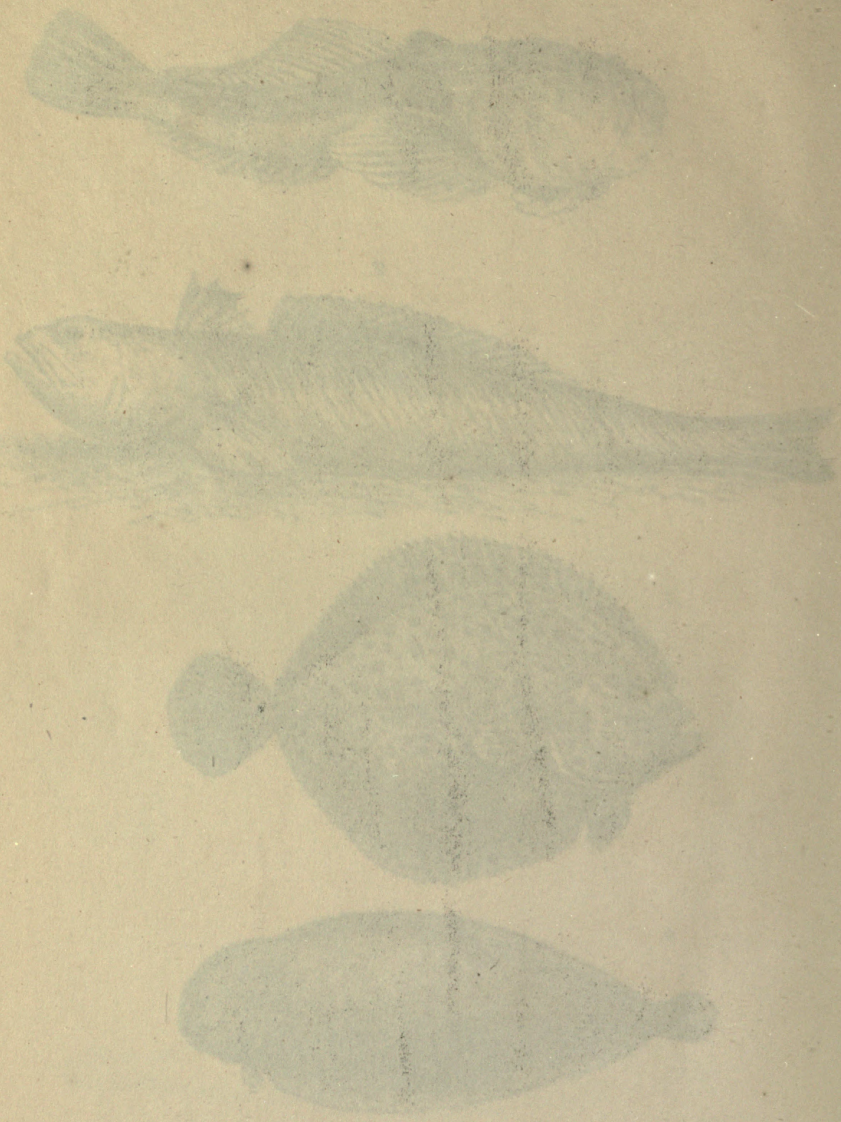
5. Amphioxus lanceolatus.

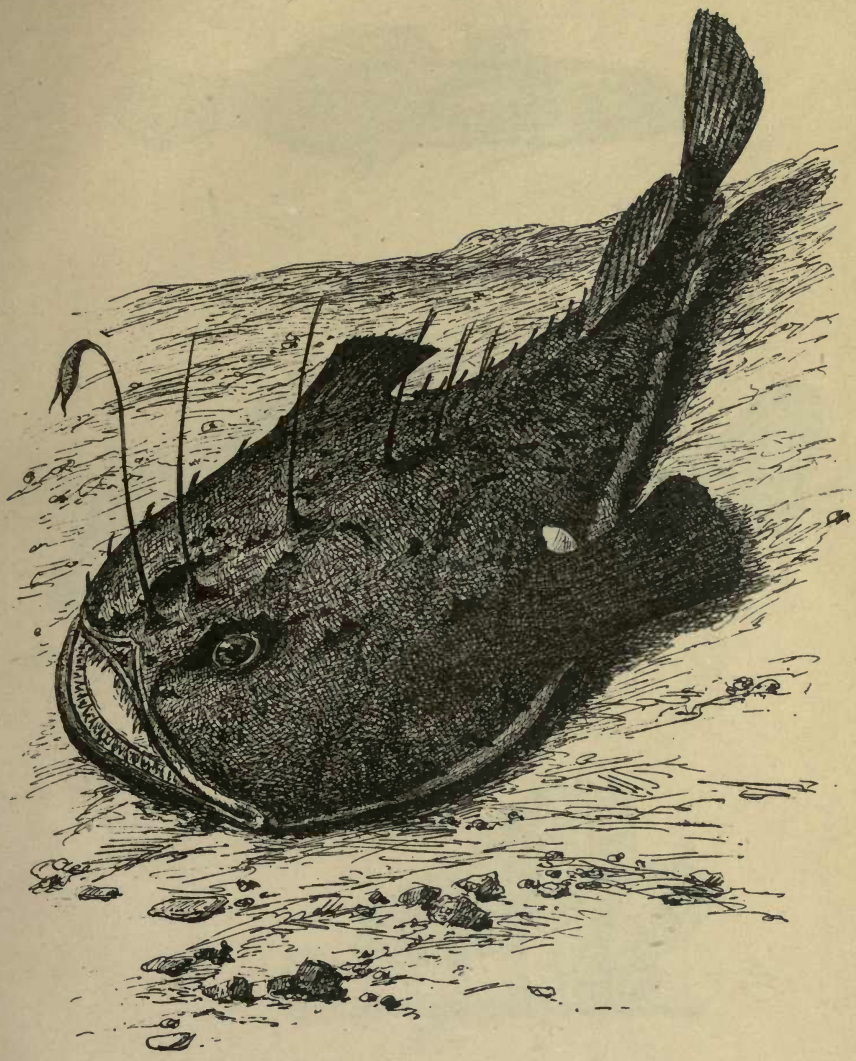
C. Merculiano fec. Werner & Winter, impr.



1. *Uranoscopus scaber.*
2. *Trachinus draco.*
3. *Rhombus maximus.*
4. *Solea vulgaris.*

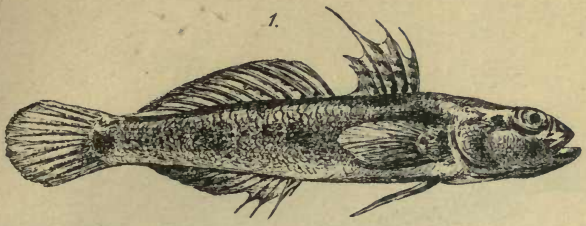
C. Merculiano fec. Werner & Winter, impr.

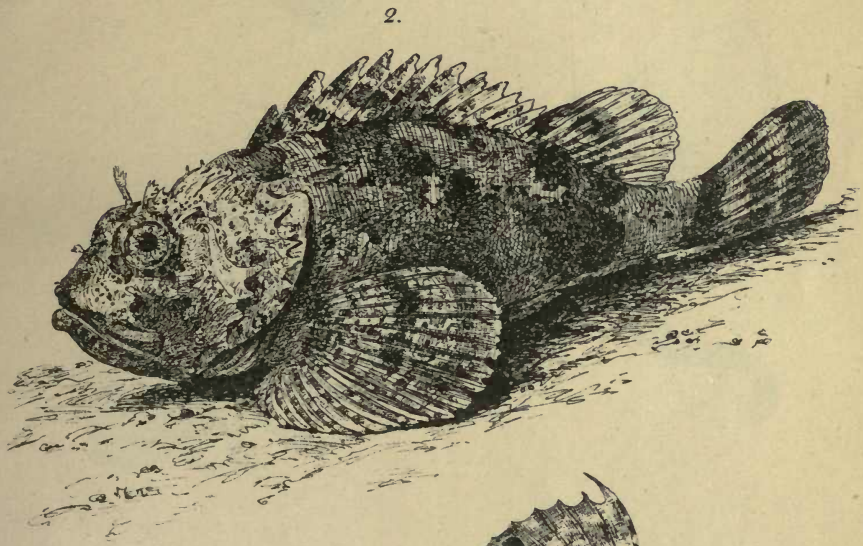


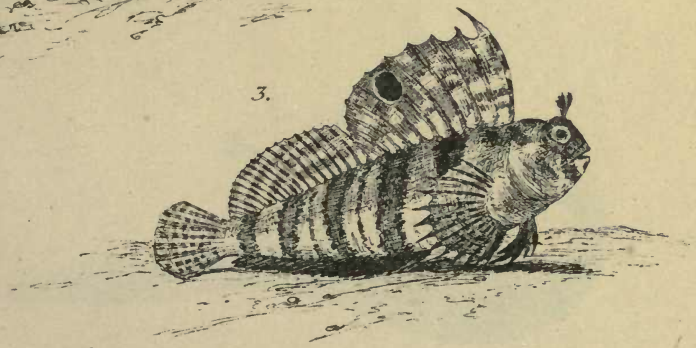


Lophius piscatorius.

C. Merculiano fec. Werner & Winter, impr.

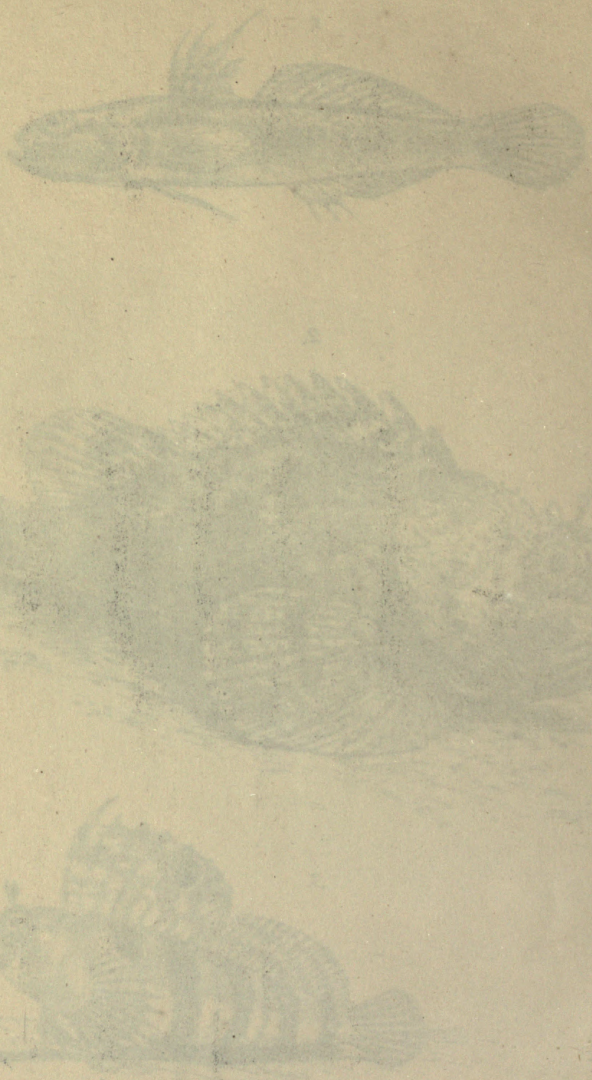






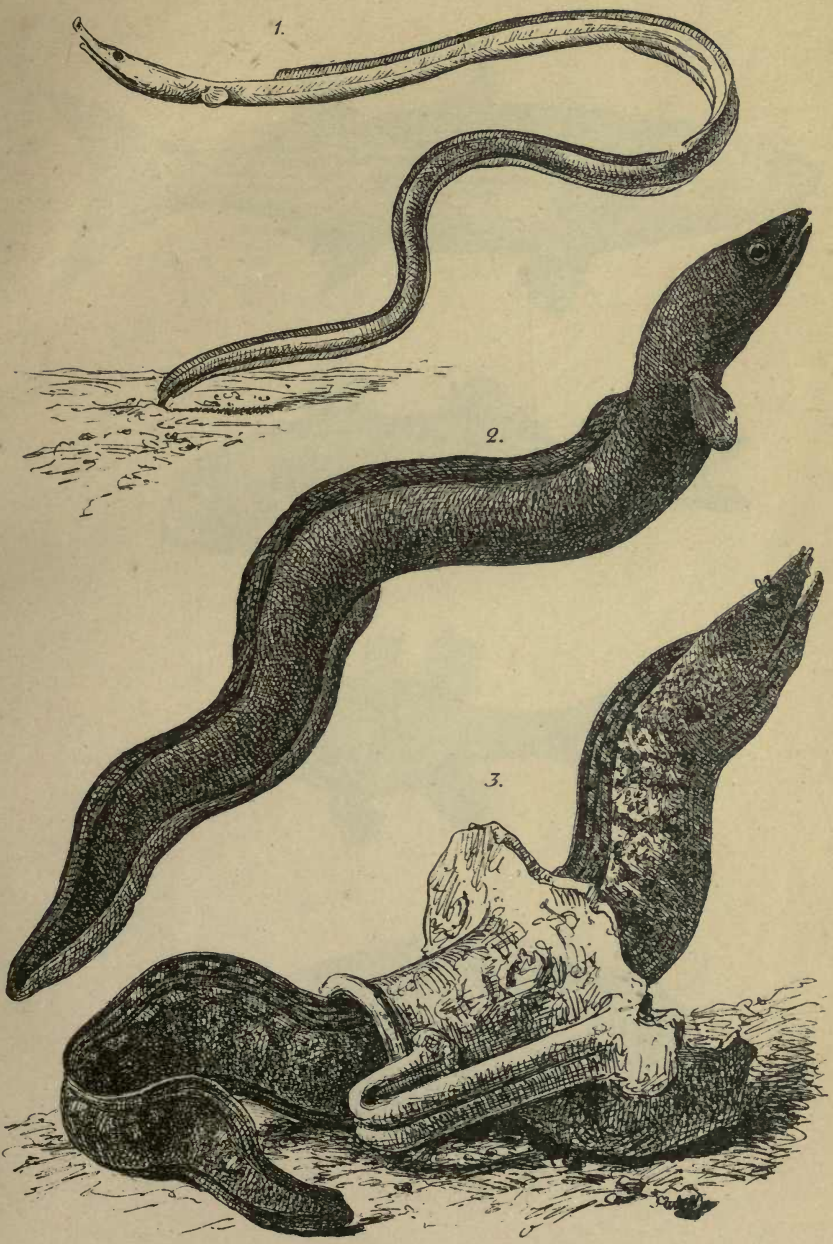
1. Gobius capito. *2. Scorpaena porcus.*
3. Blennius ocellaris.

C. Merculiano fec. Werner & Winter, impr.



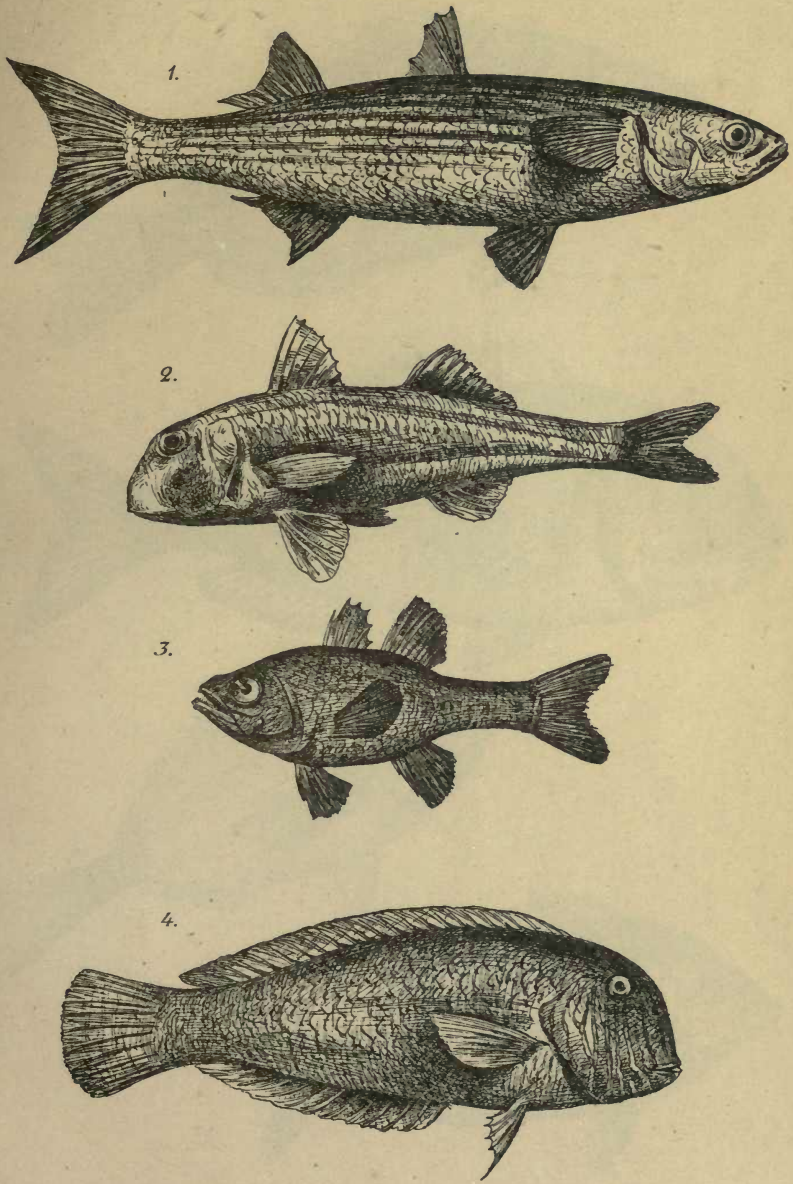
1. *Trigla lyra.*
2. *Dactylopterus volitans.*
3. *Hippocampus guttulatus.*
4. *Syngnathus acus.*

C. Merculiano fec. Werner & Winter, impr.



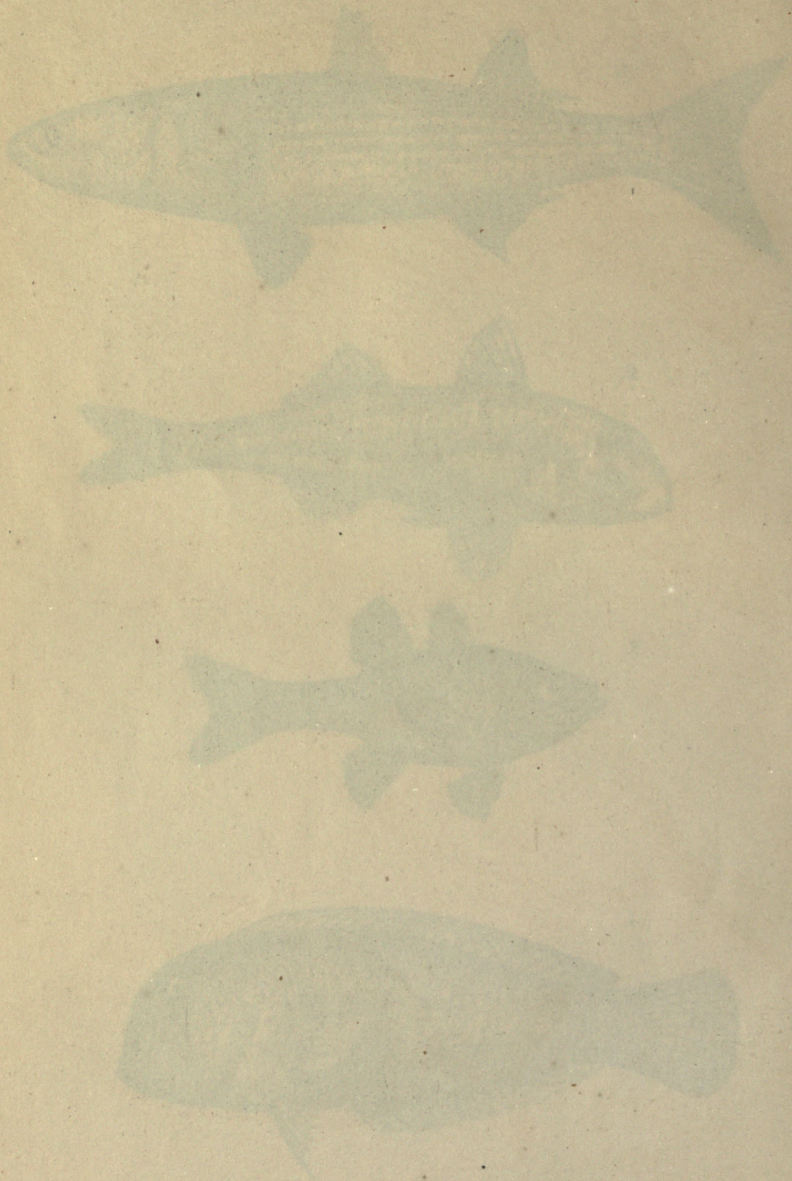
1. Ophisurus serpens. *2. Conger vulgaris.*
3. Muraena helena.

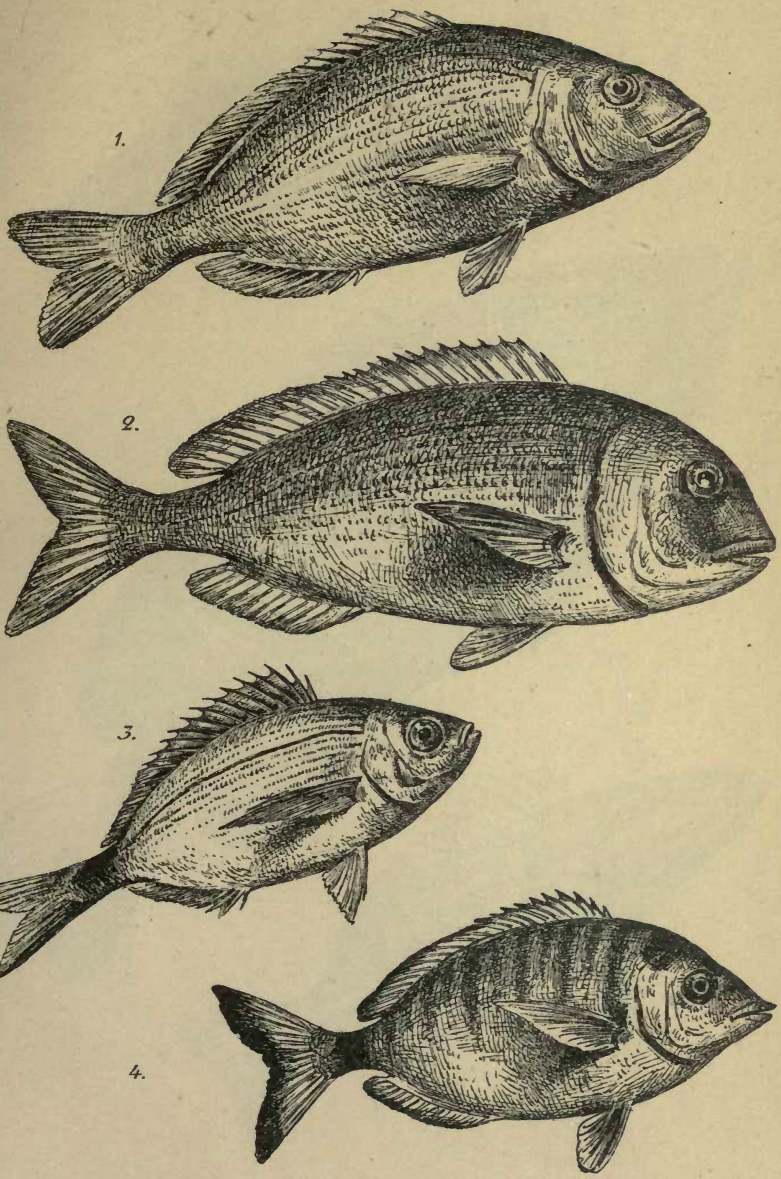
C. Merculiano fec. Werner & Winter, impr.



1. *Mugil cephalus.*
2. *Mullus barbatus.*
3. *Apogon rex mullorum.*
4. *Xirichthis novacula.*

C. Merculiano fec. Werner & Winter, impr.

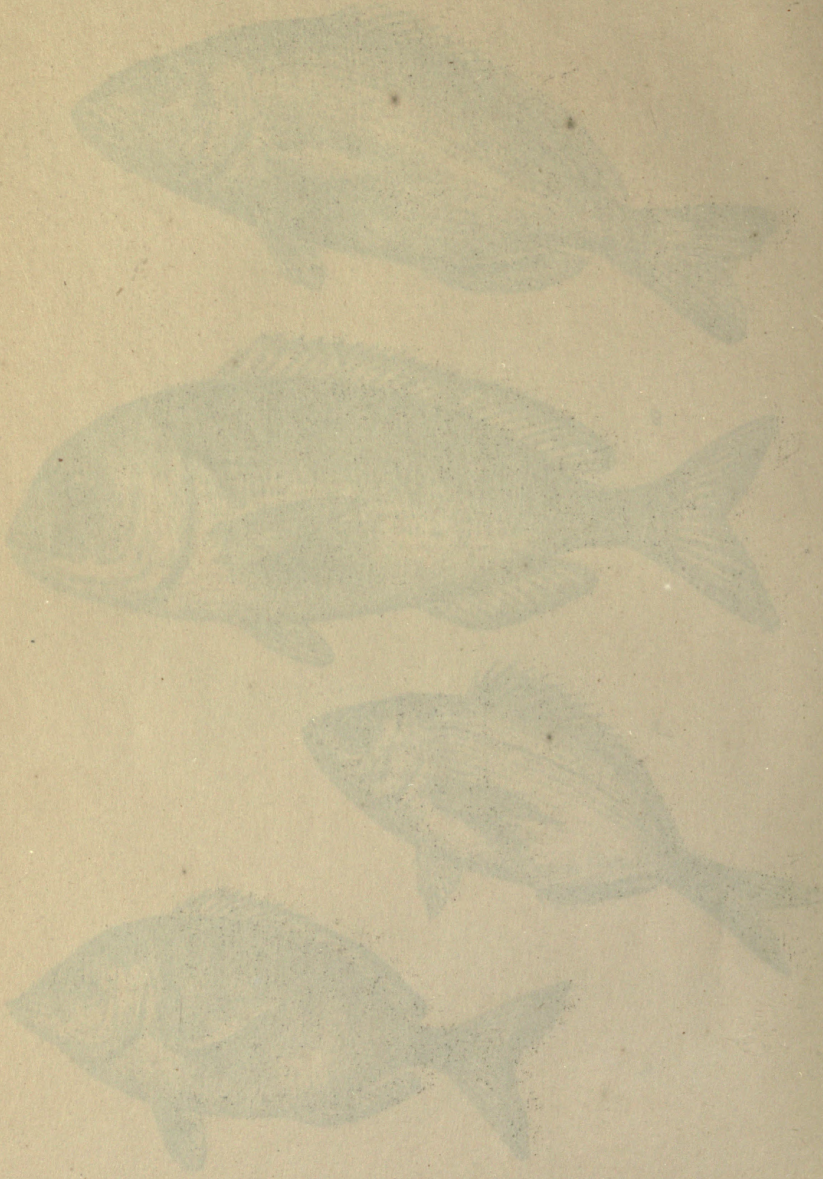


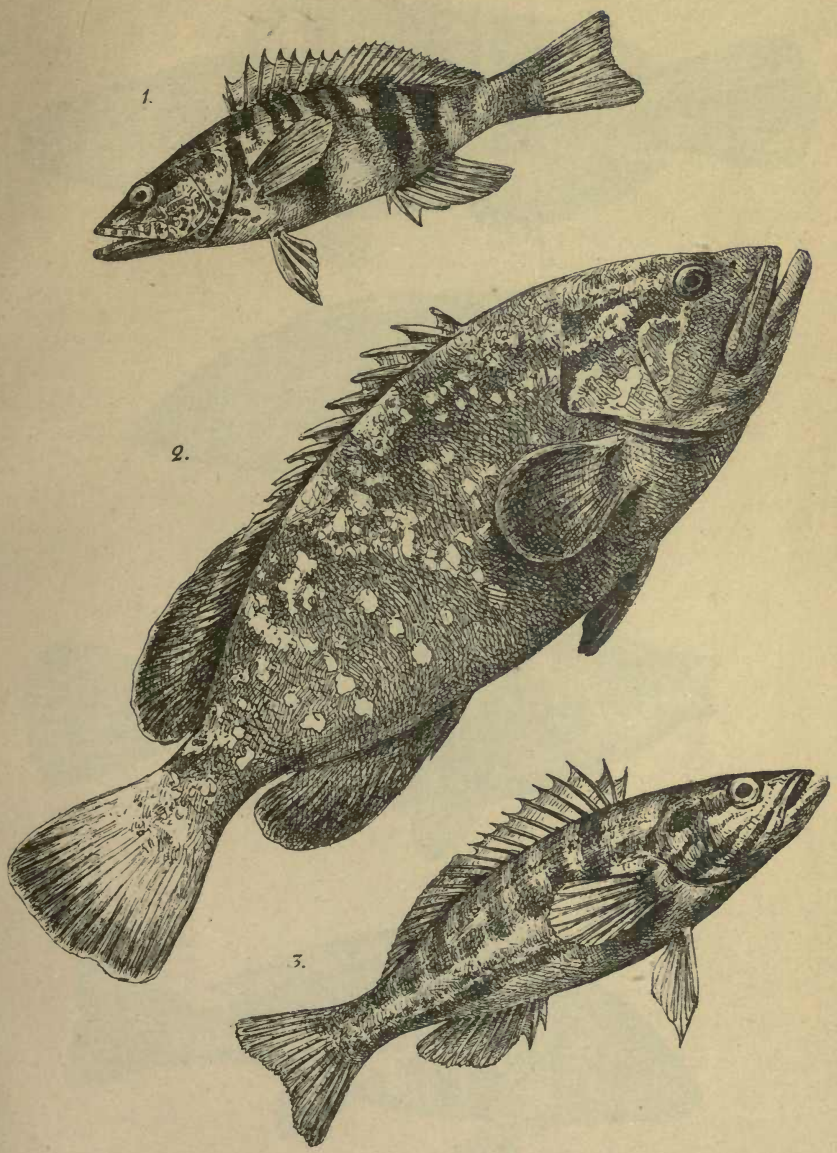


1. *Dentex vulgaris.*
2. *Pagellus erythrinus.*
3. *Oblada melanura.*
4. *Carax puntazzo.*

C. Merculiano fec.

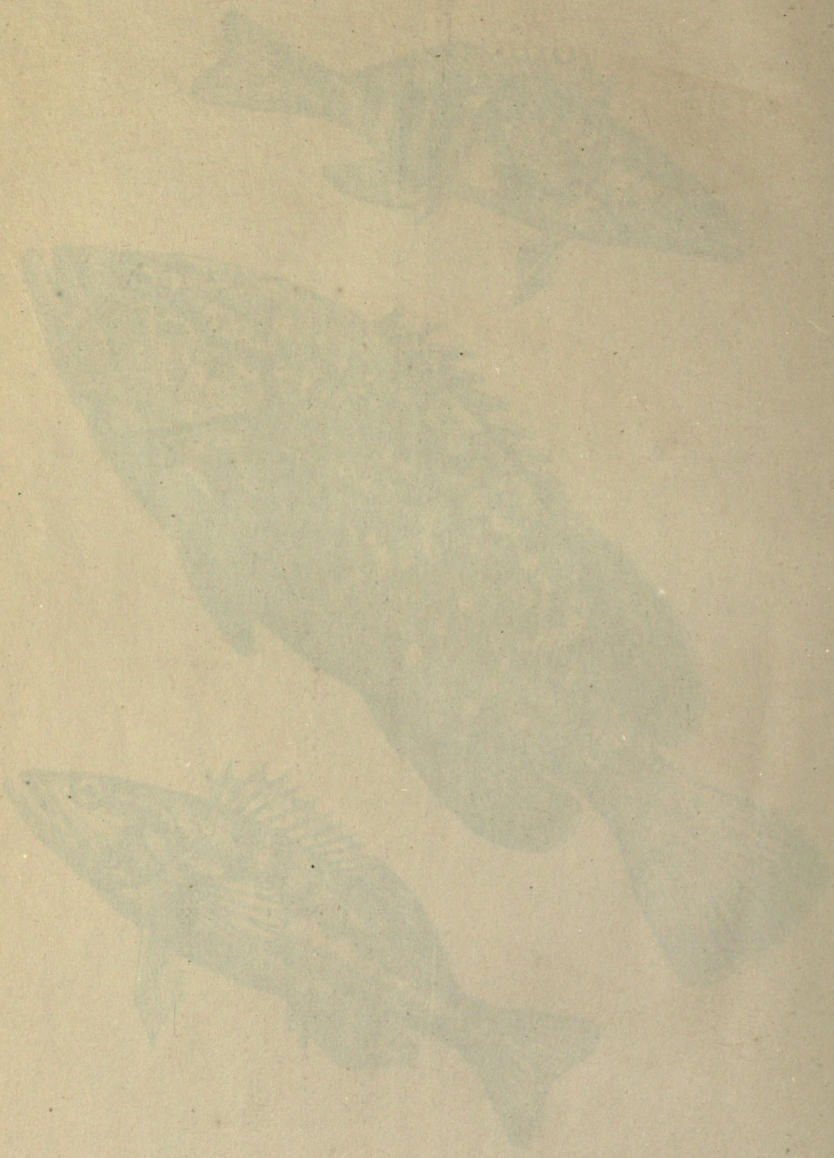
Werner & Winter, impr.

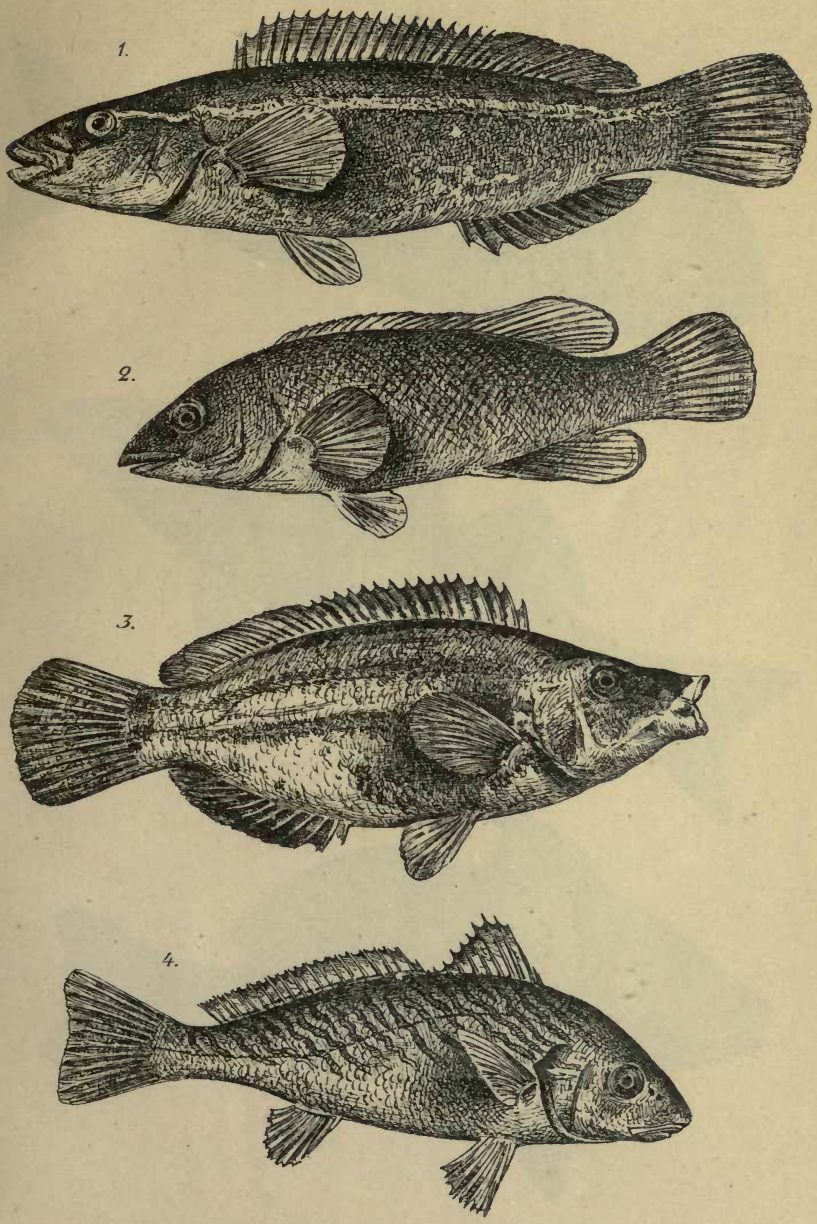




1. Serranus scriba. *2. Serranus gigas.*
3. Serranus cabrilla.

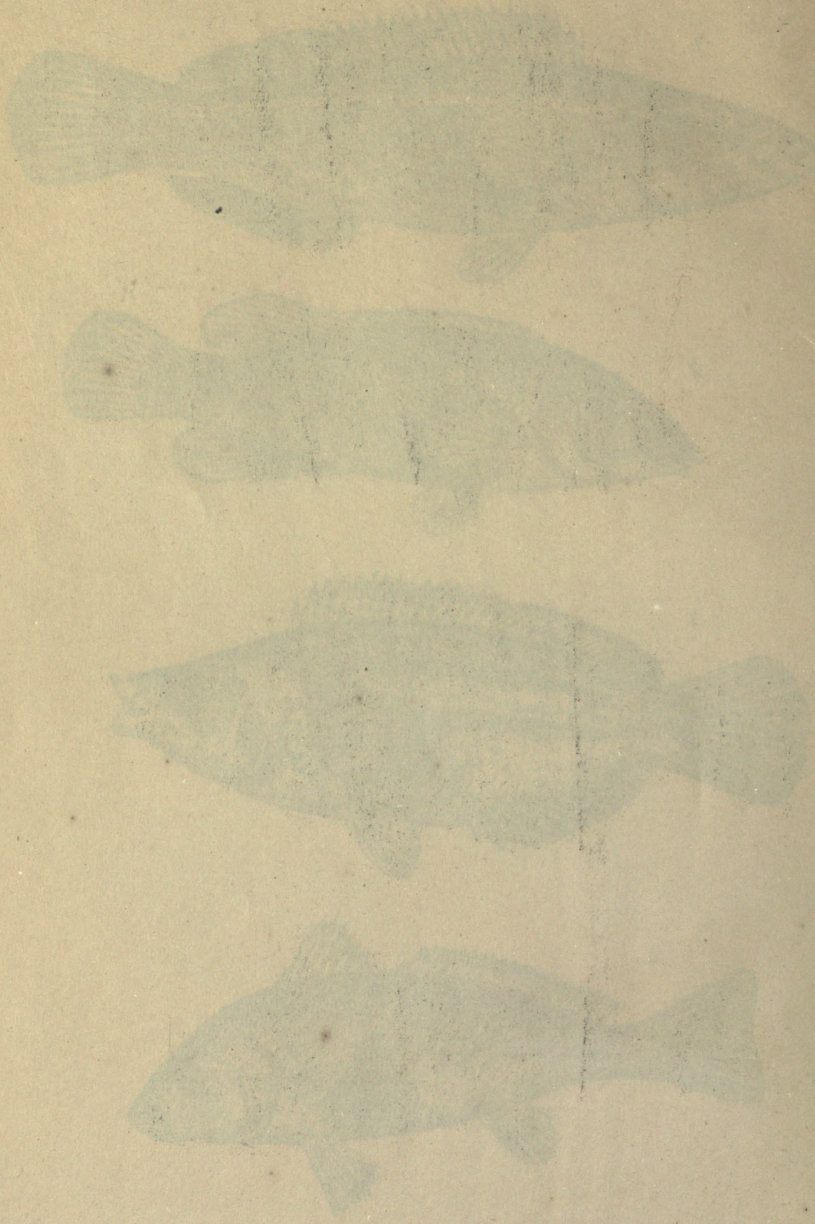
C. Merculiano fec. Werner & Winter, impr.

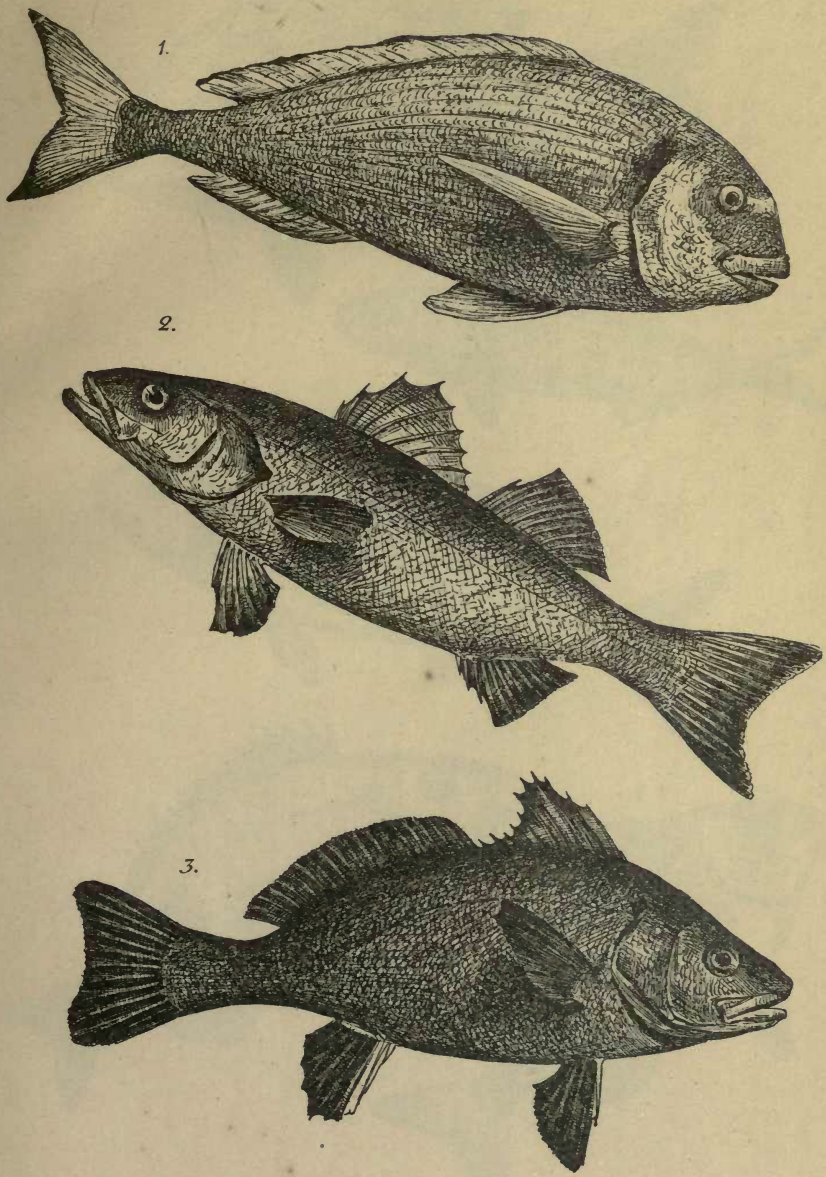




1. *Labrus festivus.*
2. *Labrus merula.*
3. *Crenilabrus pavo.*
4. *Umbrina cirrosa.*

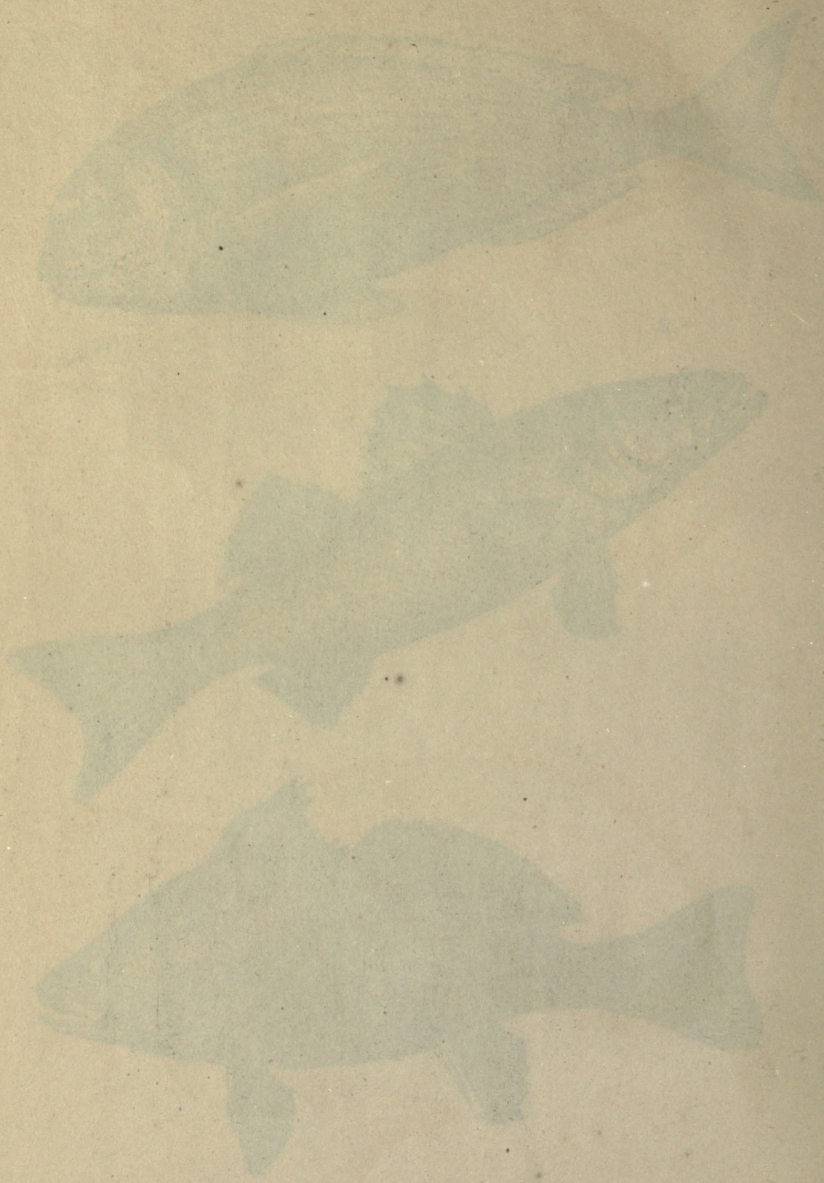
C. Merculiano fec. Werner & Winter, impr.

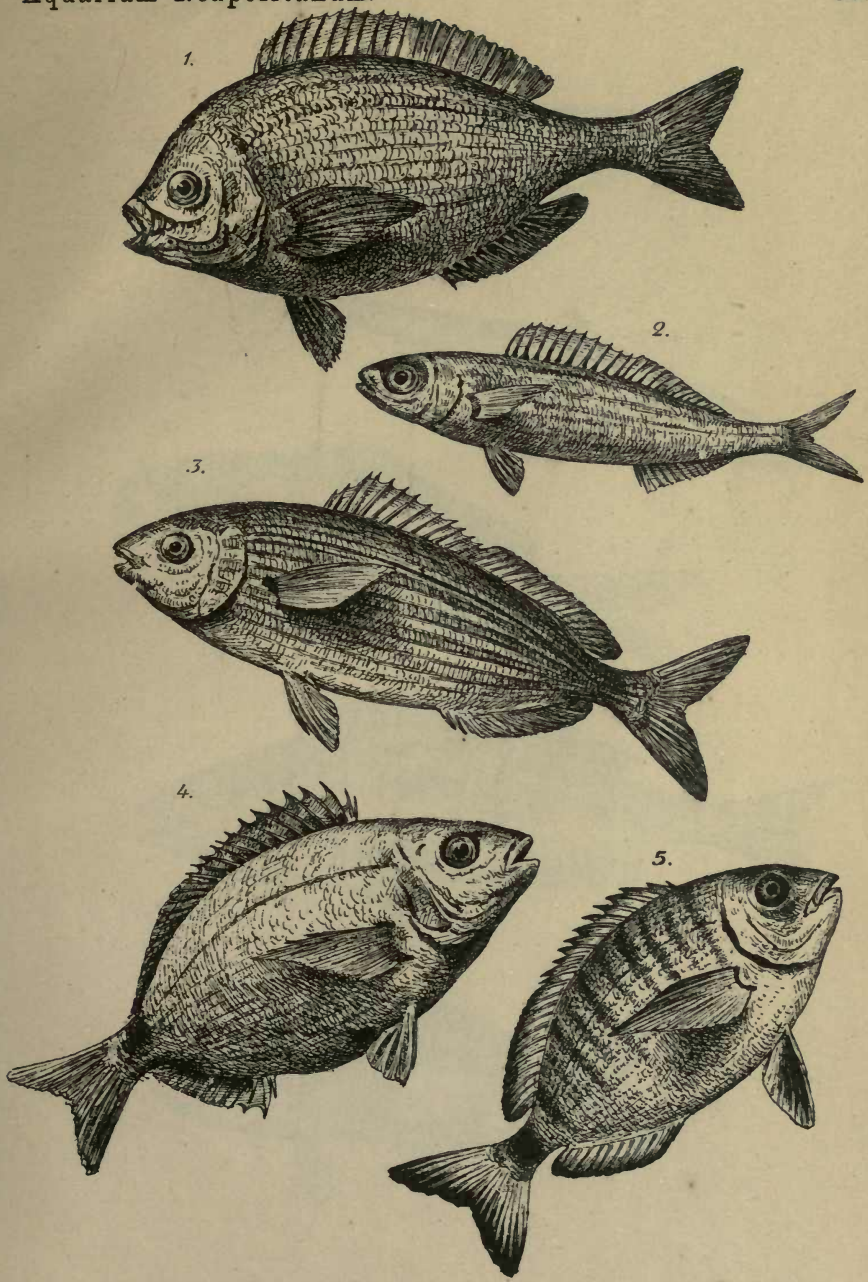




1. Chrysophrys aurata. *2. Labrax lupus.*
3. Corvina nigra.

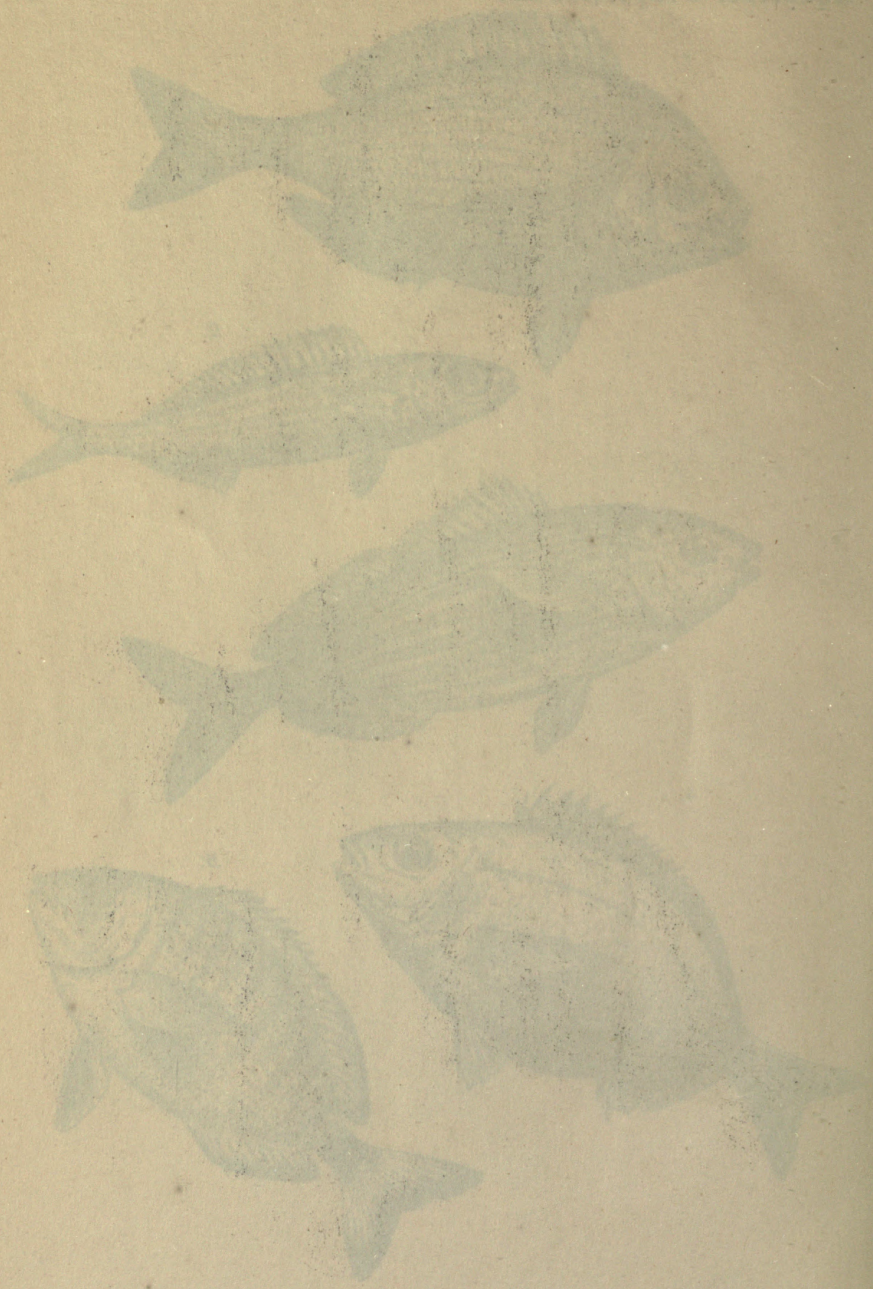
C. Merculiano fec. Werner & Winter, impr.

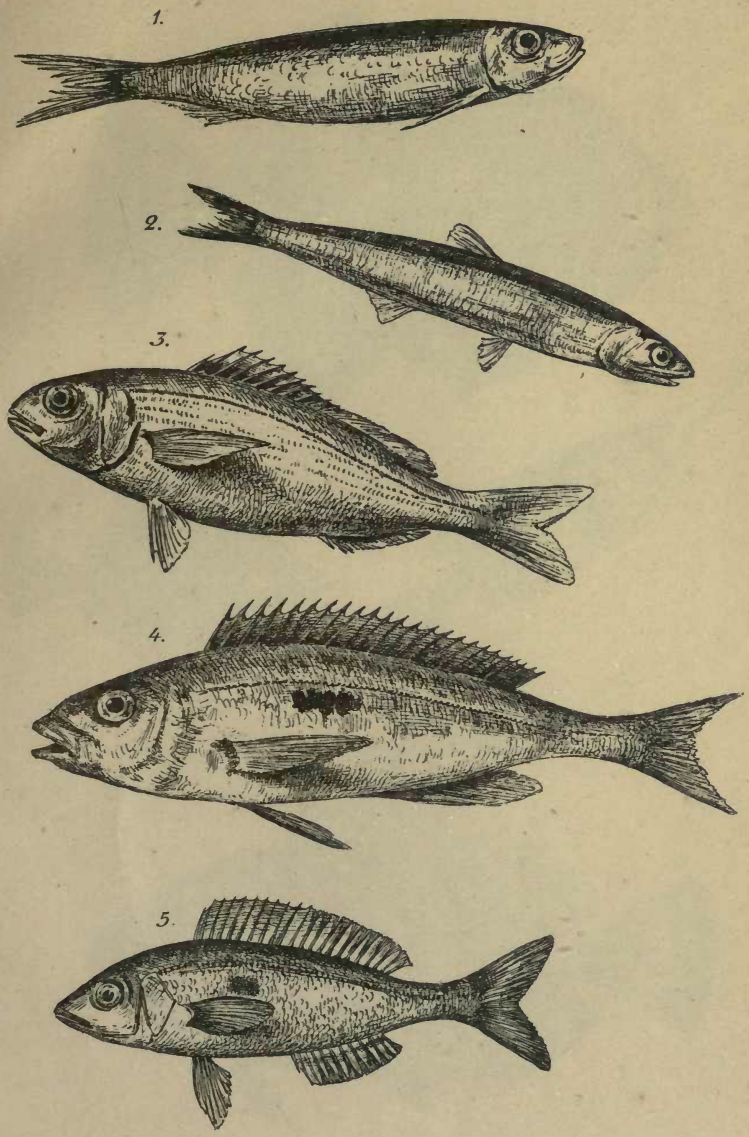




1. *Cantharus vulgaris.* 2. *Box boops.*
3. *Box salpa.* 4. *Sargus anularis.*
5. *Sargus Rondeletii.*

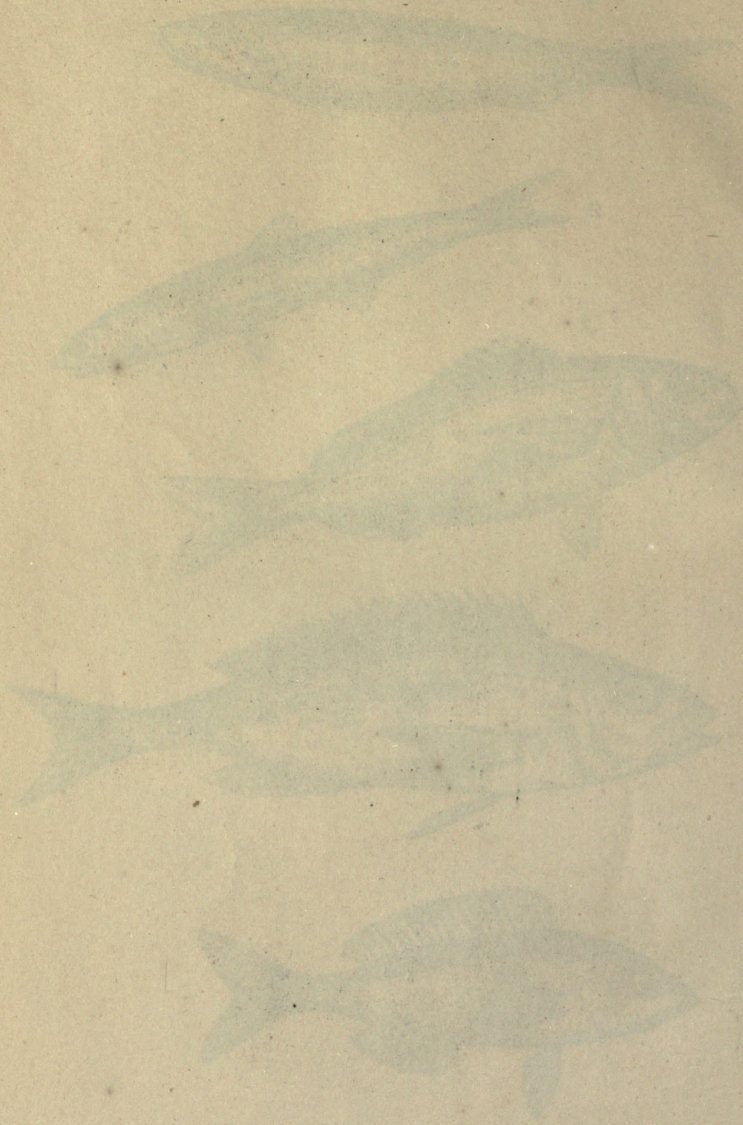
C. Merculiano fec. Werner & Winter, impr.

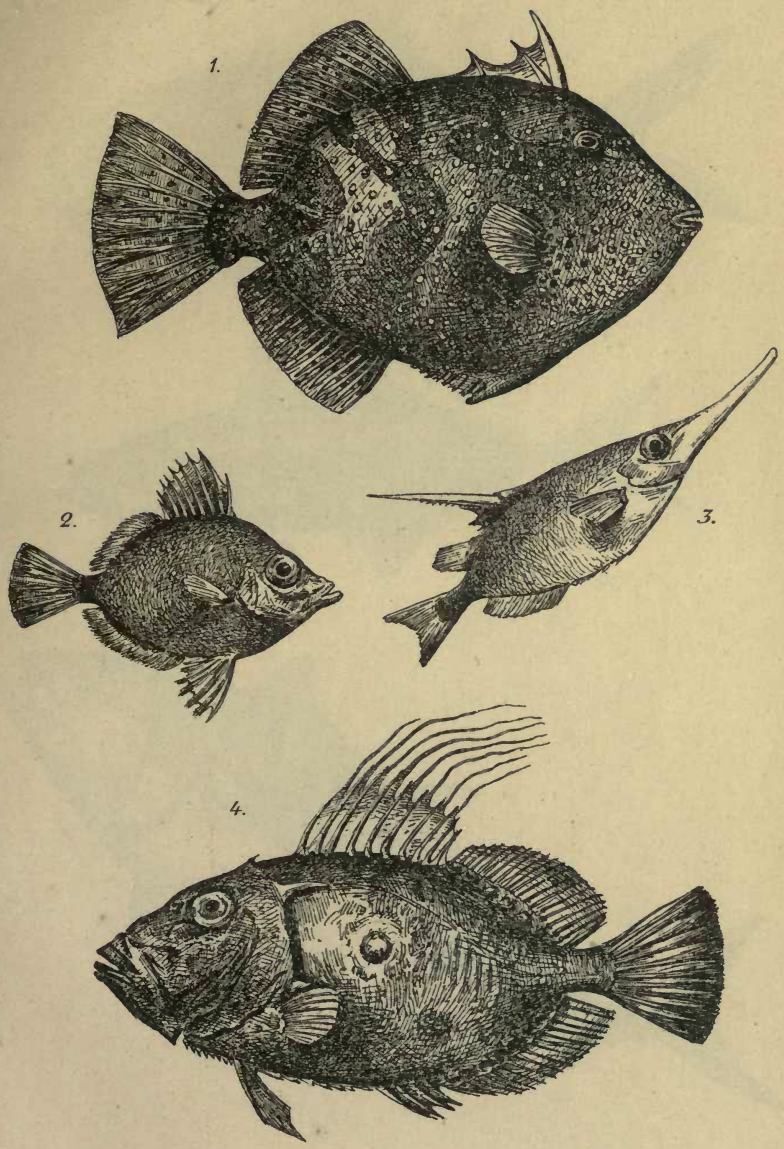




1. *Alosa sardina.* 2. *Engraulis encrasicholus.*
3. *Pagrus vulgaris.* 4. *Maena vulgaris.*
5. *Smaris vulgaris.*

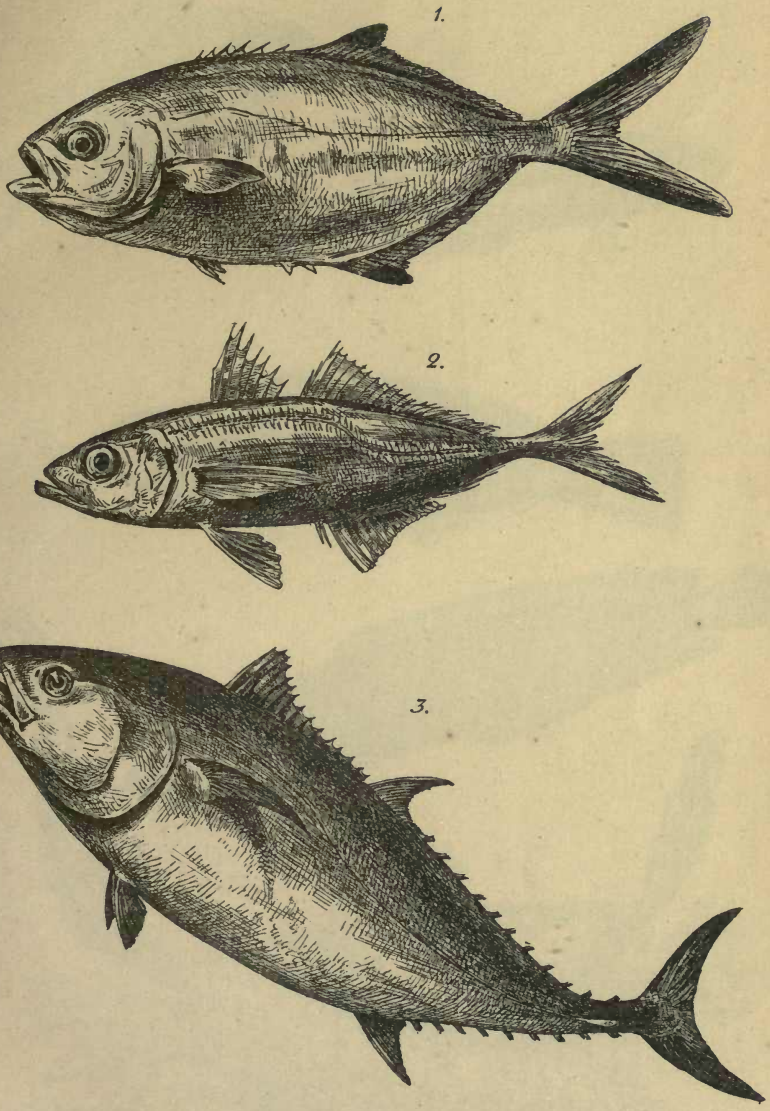
C. Merculiano fec. Werner & Winter, impr.





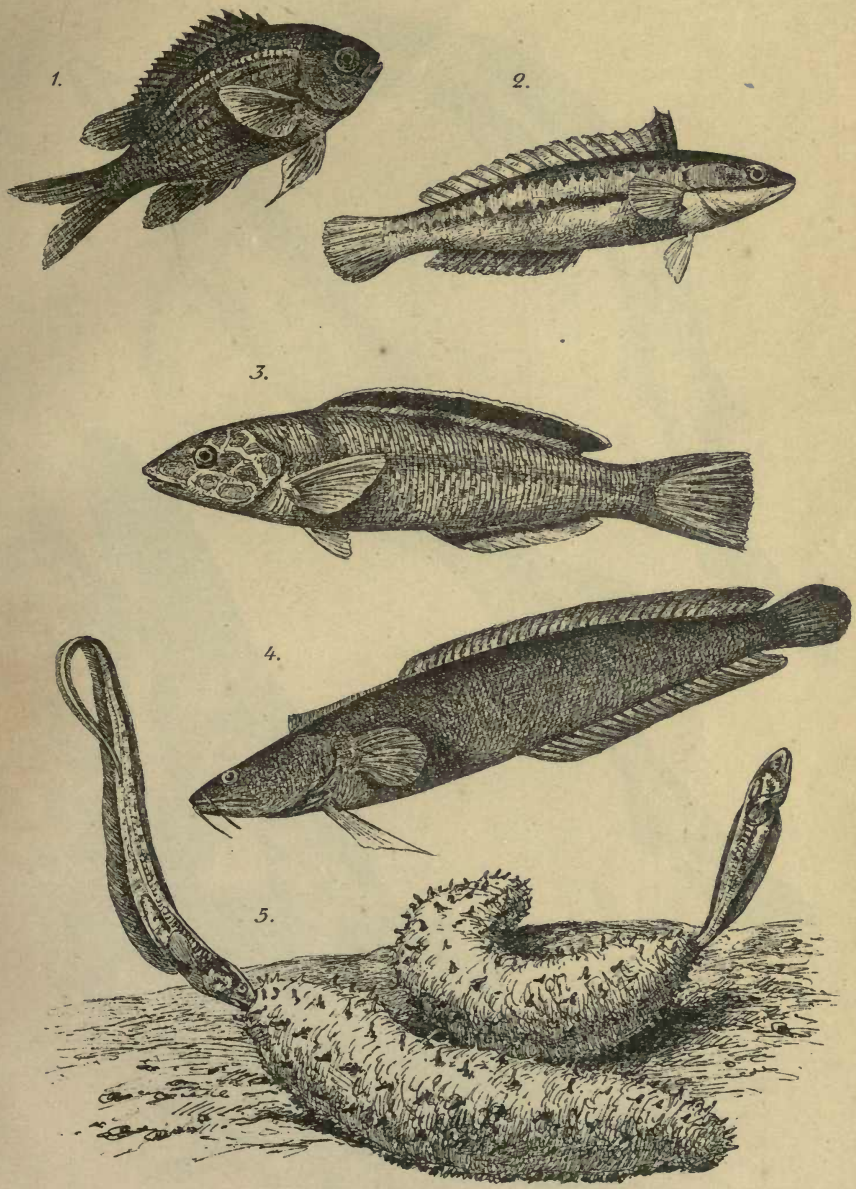
1. Balistes capriscus. *2. Capros aper.*
3. Centriscus scolopax. *4. Zeus faber.*

C. Merculiano fec. Werner & Winter, impr.



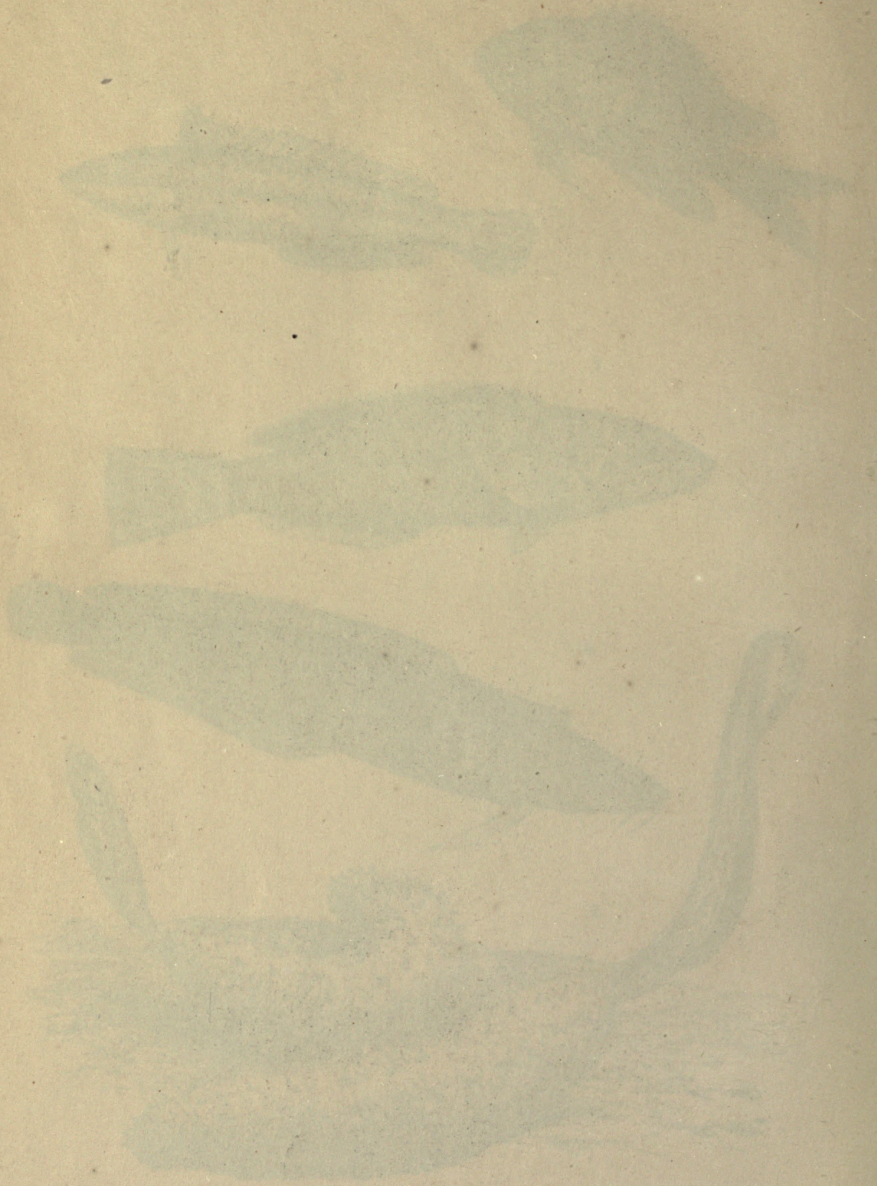
1. Lichia glauca. *2. Caranx trachurus.*
3. Thynnus vulgaris.

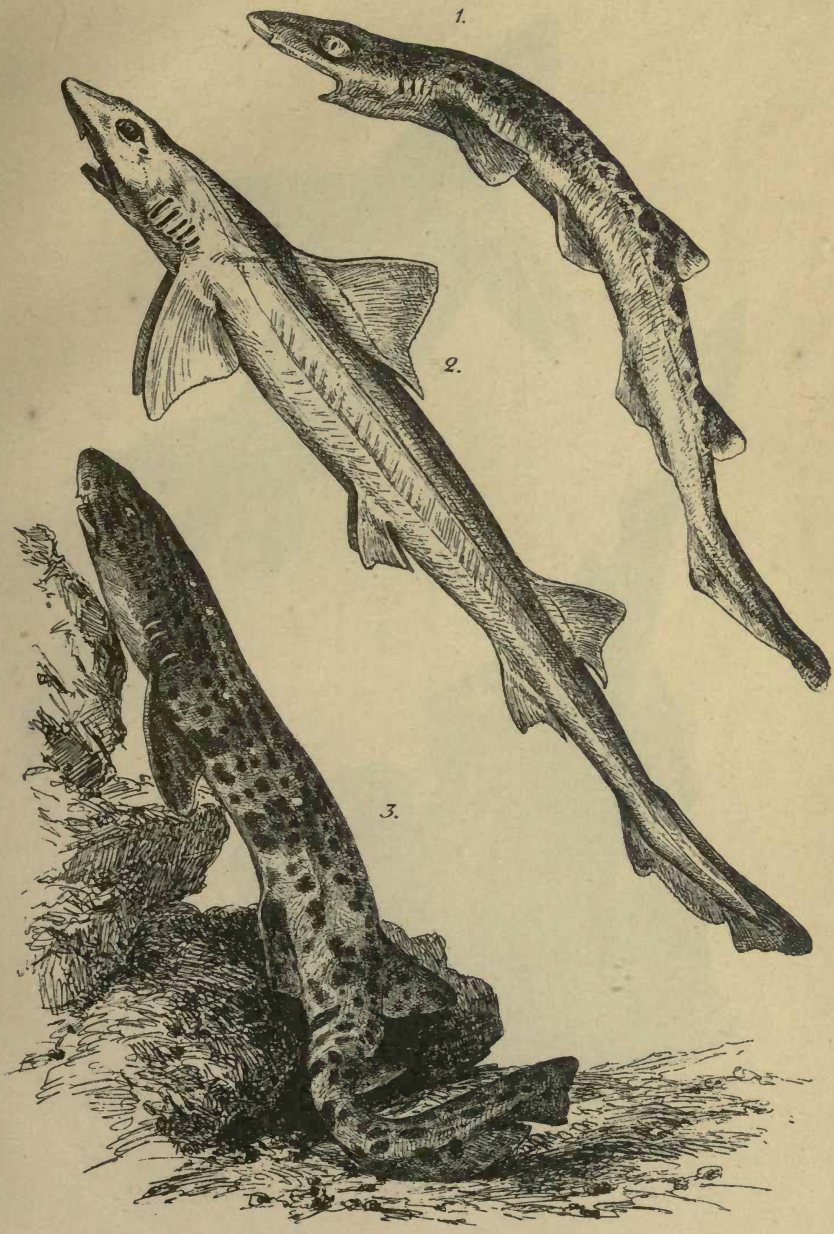
C. Merculiano fec. Werner & Winter, impr.



1. Heliases chromis. *2. Julis vulgaris.*
3. Julis turcica. *4. Motella vulgaris*
5. Fierasfer acus (et Holothuria).

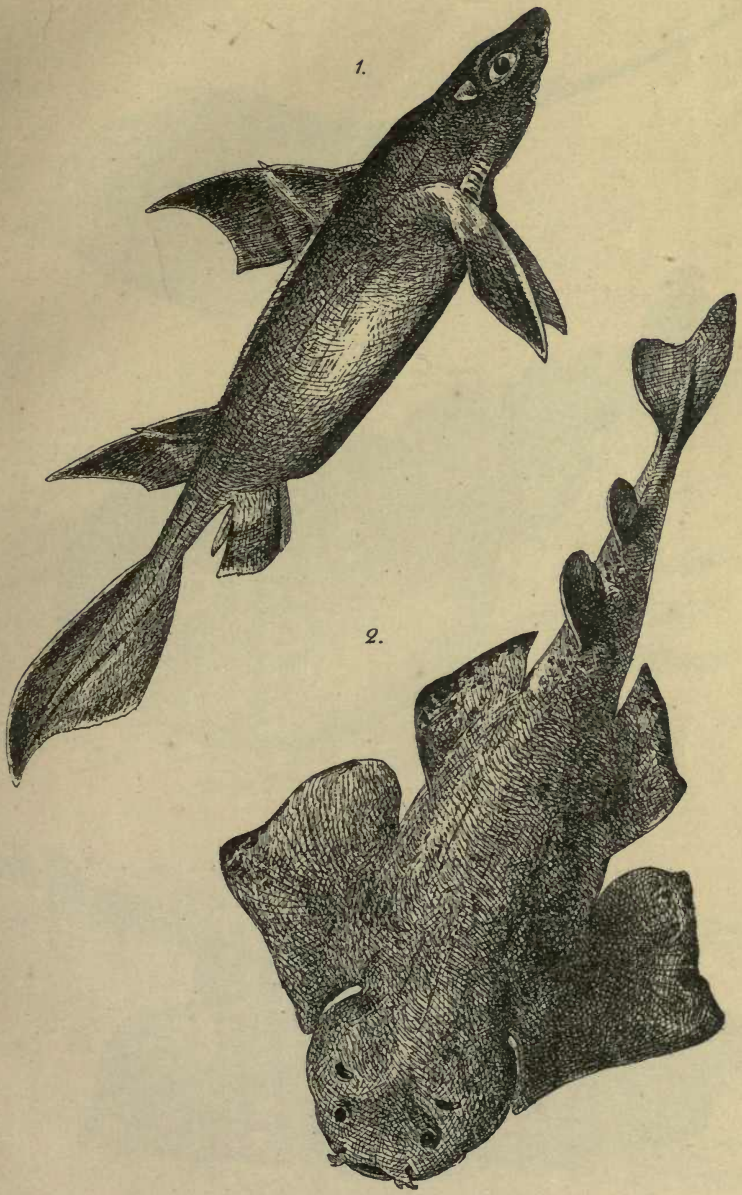
C. Merculiano fec. Werner & Winter, impr.





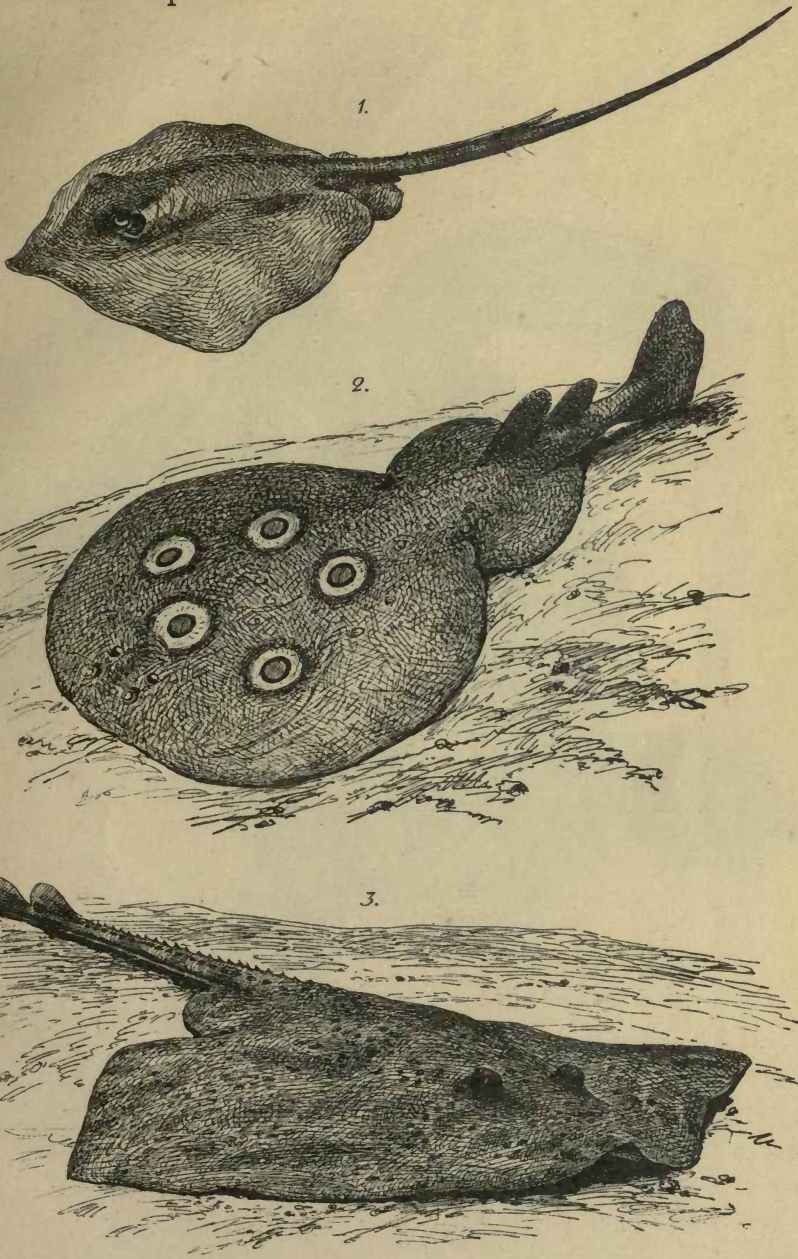
1. Pristiurus melanostomus. *2. Mustelus laevis.*
3. Scyllium catulus.

C. Merculiano fec. Werner & Winter, impr.



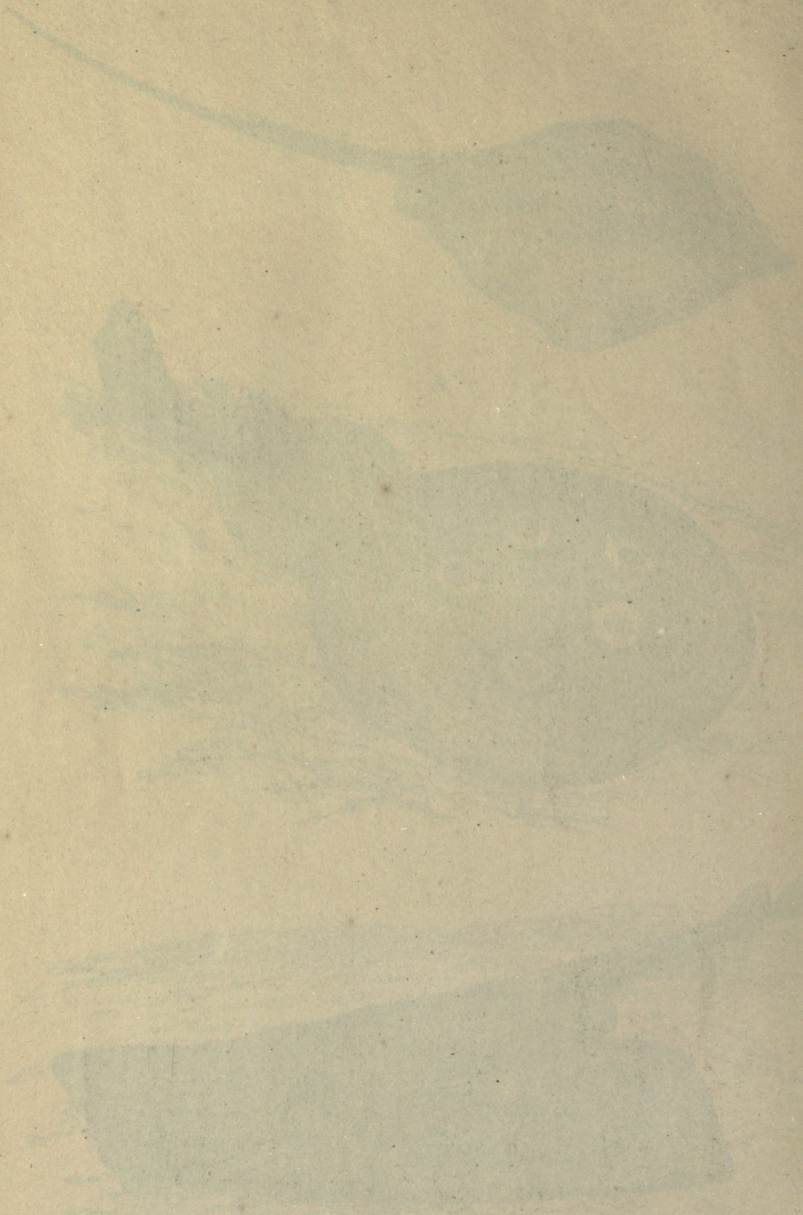
1. Centrina Salviani. *2. Squatina angelus.*

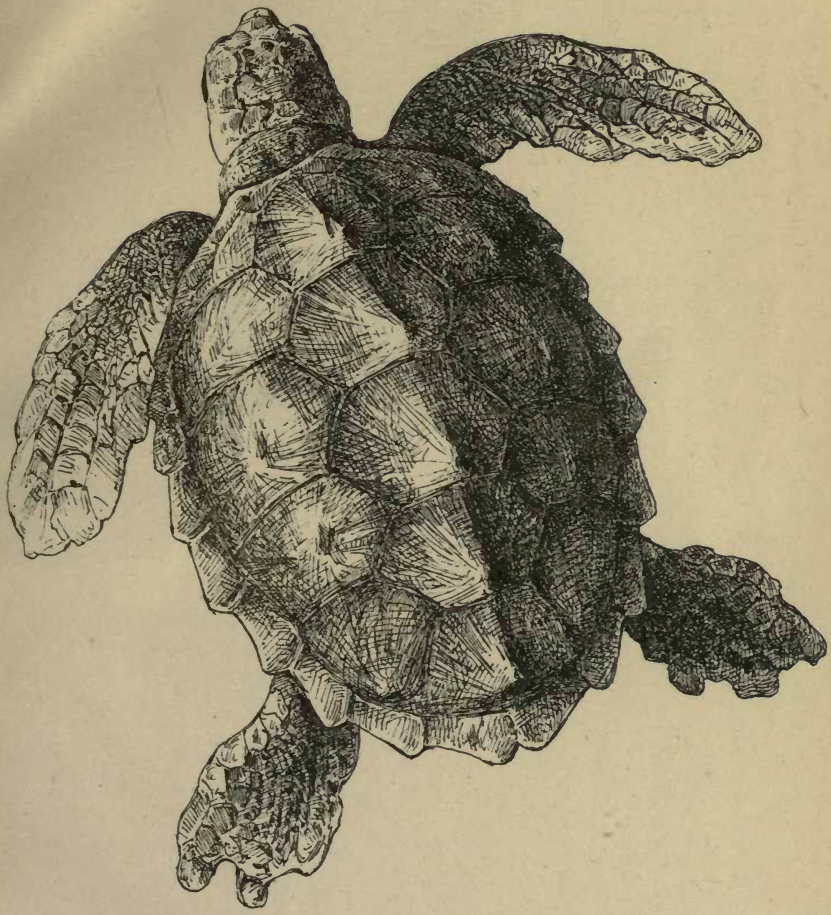
C. Merculiano fec. Werner & Winter, impr.



1. Trygon violaceus. *2. Torpedo ocellata.*
3. Raja asterias.

C. Merculiano fec. Werner & Winter, impr.





Thalassochelys corticata.

C. Merculiano fec. Werner & Winter, impr.